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NOTICE.

PALÆONTOLOGICAL researches forming so essential a part of geological investigations, such as those now in progress by the Geological Survey of the United Kingdom, the accompanying plates and descriptions of British Fossils have been prepared as part of the Geological Memoirs. They constitute a needful portion of the publications of the Geological Survey, and are taken from specimens in the public collections, or lent to the Survey by those anxious to advance this branch of the public service. Although numerous drawings had previously been made, and engravings from them considerably advanced, it was not thought expedient to commence their publication until the large collections of the Survey could be well examined, which a want of the needful space has, until the present time, considerably retarded. This impediment to progress is now being removed, and when the collections can be properly displayed in the New Museum of Practical Geology, in Jermyn Street, it is hoped that the public will have an opportunity of gradually obtaining, in a convenient manner and at small cost, a work illustrating some of the more important forms of animal and vegetable life there preserved, and which have been entombed during the lapse of geological time in the area occupied by the British islands.

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MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Gt. Brit. Geological Survey

Figures and Deſcriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE I.

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classes of animals and plants the remains of which are contained in British rocks; to select especially such as require an amount of illustration which, to be carried out by private enterprise, would require a large outlay of money, with little prospect of a return, and a long time to accomplish, but which, by means of the staff and appliances necessarily employed on the Geological Survey, can be effected at small cost, and with a rapidity demanded by the publication of the maps and memoirs of the Survey; thus, it is hoped, affording an aid to those engaged in the sciences with which this work is connected, that they might not otherwise have possessed, and which may materially promote the progress of individual research.

H. T. De la Beche,
Director-General.

Geological Survey Office,
24th May, 1849.

BRITISH FOSSILS.

DECADE THE FIRST.

THE first Decade of representations of British Fossils is devoted to a selection of Echinoderms, of the Orders *Asteriadæ* and *Echinidæ*.

With the exception of the *Crinoideæ* and *Cystideæ*, no special monographs have been devoted to the illustration of our fossil species of Echinodermata, notwithstanding their acknowledged importance in a geological point of view. The majority of species found in British strata are unfigured in British works; a very great number are not figured at all, and those of which we possess British figures are, for the most part, delineated either imperfectly or insufficiently for the demands of science in its present state. This is the more remarkable since, for the description and delineation of numerous species, ample materials exist in collections.

Of the following plates, one is devoted to figures of all the Silurian star-fishes as yet discovered in British strata. None of these have hitherto been represented in any work. Their names only, accompanied by short descriptive characters, have appeared in the "Synopsis of British Fossil Asteriadæ," contained in the second part of the second volume of the "Memoirs of the Geological Survey of Great Britain." Some remarkable new forms of star-fishes from the Oolites, and all as yet discovered in the London clay, are figured in the second and third plates.

The fourth plate is devoted to a representation of the only fossil as yet discovered of the family *Euryales*, now for the first time described and figured, through the kind co-operation of the Rev. Professor Sedgwick.

In the six following plates a series of illustrations of the British fossil *Echinidæ* is commenced, of the majority of which, even the commonest and those most important for the identification of strata, no good representations are accessible to the student of English fossils. The importance of a knowledge of the members of this family to the explorers of oolitic and cretaceous strata cannot be too strongly insisted on, and their beauty and interest, in a purely Natural History point of view, render them admirable subjects for elaborate delineations.

When the collections accumulated during the course of the progress of the Geological Survey have been thoroughly examined and arranged, new light may be expected, bearing on the details of structure of the species now figured. Additions will consequently be made to the plates from time to time; and it is proposed to issue supplementary figures of the variations of form exhibited by the several species selected as subjects for these decades.

EDWARD FORBES.

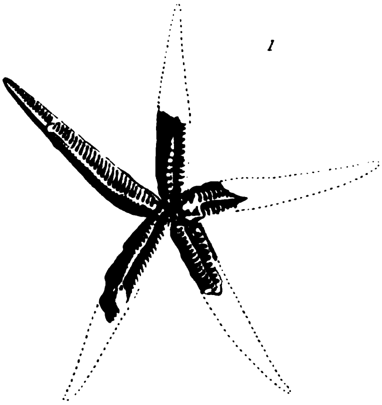
May, 1849.

DECADE I. PL. I.

Geological Survey of the United Kingdom.

URASTER
Silurian

1



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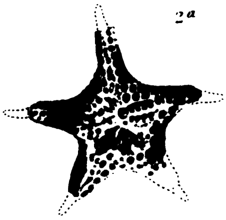

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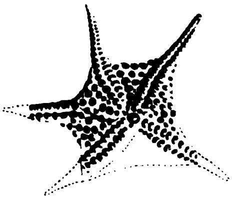

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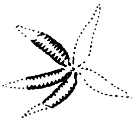

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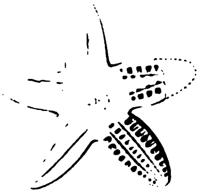


1 URASTER RUTHVENI *Forbes.* 3 —— OBTUSUS *Forbes.*
2 —— PRIMÆVUS *Forbes.* 4 —— HIRUDO *Forbes.*

BRITISH FOSSILS.

DECADE I. PLATE I.

SILURIAN SPECIES OF URASTER.

[Genus URASTER. AGASSIZ. (Sub-kingdom Radiata. Class Echinodermata. Order Asteriadæ. Family Urasteriæ). Body stellate, five-rayed; a vent on the dorsal surface; rays rounded, surface spinous; ossicula small, compressed, irregular, reticularly combined; ambulacra bordered by three sets of spines; suckers quadriserial. The genera ASTERACANTHION of MÜLLER and TROSCHEL, and ASTERIAS (restricted) of J. E. GRAY, are synonymous with URASTER.]

FIG. 1.

URASTER RUTHVENI.

E. FORBES, in " Memoirs of the Geological Survey of Great Britain," vol. ii. part 2, p. 463.

DIAGNOSIS. *U. brachiis quinis teretibus, longissimis, angustis, subcarinatis; disco parvo; paginâ superiori reticulatâ, spinosâ, spinis obtusis fasciculatis. Ossiculis ambulacralibus linearibus, longis, geniculatis.*

Description.—Body very small, in the centre of five tapering linear lanceolate, rounded rays, subcarinated on their upper surfaces, five times as long as the disk is broad. The upper surfaces of both rays and disk are reticulated, indicating a structure which originally in all probability consisted of spines grouped in tufts. The under surfaces are marked by the impressions of a double series of ambulacral articulations, each slightly curved. Both these structures are present in some existing antarctic forms of *Uraster.* The largest specimen examined measured three inches and a half across, from arm-tip to arm-tip.

Affinities.—The slender lanceolate arms distinguish this species from any of its palæozoic allies as yet described. In general form it resembles some living species.

Locality and Geological Position.—This interesting starfish was discovered by Mr. John Ruthven, in strata of the Ludlow division of Silurian rocks at Scalthwaiterigg, and also at Highthorns, both near Kendal, in Westmoreland. Professor Sedgwick, in whose collection it is contained, kindly communicated the specimen for description and delineation.

FIG. 2 *a.* (upper side) and *b.* (under side).

URASTER PRIMÆVUS.

E. FORBES, in "Memoirs of the Geological Survey of Great Britain," vol. ii. part 2, p. 463.

DIAGNOSIS. *U. brachiis quinis, brevibus, triangularibus, acuminatis; disco lato. Paginâ superiori tuberculatâ, reticulatâ (spinosâ? spinis obtusis fasciculatis?) ossiculis ambulacralibus oblongis, latis, geniculatis.*

Description.—Body very broad, pentagonal, produced at the angles into five short lanceolate or elongato-triangular pointed arms, which are each about two-thirds as long as the breadth of the disk. Surface of the disk convex above, as well as the arms tuberculated and reticulated, exhibiting traces of having been covered by tufts of short blunt spines. Madreporiform plate sub-central, as well as vent. Beneath nearly flat, the interambulacral spaces reticulated like the upper surface, the ambulacra composed of broad, oblong, geniculated plates, of which there are about twenty in a row. The largest specimens examined had attained the dimensions of an inch and a half in diameter, measuring from arm-tip to arm-tip.

Affinities.—The general shape of this species reminds us of *Asterina*, but its structure is so similar to that of the next fossil to be described, that I do not doubt it was a true *Uraster*. The pointed rays distinguish it at sight from *U. obtusus*, its nearest ally.

Locality and Geological Position.—First found by Mr. John Ruthven, in the Silurian (Ludlow) rocks at Underbarrow, near Kendal. It occurs in a thin sub-calcareous band, loaded with encrinites and trilobites, all rare in the overlying sandstones. Numerous specimens have been collected by Professor Sedgwick and Mr. Daniel Sharpe, both of whom have communicated them for examination and delineation.

FIG. 3.

URASTER OBTUSUS.

E. FORBES, in "Memoirs of the Geological Survey of Great Britain," vol. ii. part 2, p. 463.

DIAGNOSIS. *U. brachiis quinis, brevibus, convexis, lanceolatis, obtusis; longitudine brachiarum ad latitudinem disci ut* 1 : 1¼, *ossiculis ambulacralibus oblongis, latis, interstitiis linearibus; paginâ superiori reticulato-spinosâ.*

Description.—Body rather broad (being broader than the arms are long), convex above, spinosely reticulate; the spines were short, and probably grouped in tufts. The arms are short, convex above, broad, oblong, and obtuse. Their under surfaces exhibit oblong, rather broad, ambulacral plates, gradually decreasing in size towards the tips of the arms, but nearly equal for about two-thirds of their length. The ambulacral sulcus between them is rather broad. The largest specimen examined measured an inch and a half across.

Affinities.—The contour of this fossil star-fish strikingly reminds us of that of the living *Uraster hispidus*, but the structure of its dermal covering was very different. With no fossil as yet discovered can it be confounded.

Locality and Geological Position.—First found in lower Silurian rocks, at Drumcannon, near Waterford, in 1846, by Sir Henry De la Beche, Captain James, R.E., and the describer; since by Mr. Gibbs, of the Geological Survey, in Bala rocks, at Moel y Garnedd, near Bala, North Wales. In the Irish locality it was associated with *Phacops Jamesii* and numerous *Orthides*. In the Welsh with *Orthides*, Trilobites of the genera *Asaphus* and *Homalonotus*, and numerous stems of *Encrinites*.

FIG. 4.

URASTER HIRUDO.

E. FORBES, "Memoirs of the Geological Survey of Great Britain," vol. ii. part 2, p. 464.

DIAGNOSIS. *U. brachiis quinis, lineari-lanceolatis, acuminatis, disco minuto; paginâ superiori reticulatâ, decussatâ (spinis fasciculatis, fasciculis spinarum seriebus longitudinalibus dispositis) ossiculis ambulacralibus oblongis, ambulacris latis.*

Description.—Body very minute, about a fourth as broad as the rays are long; rays tapering and linear-lanceolate, contracted at their bases, pointed at their extremities. Their upper surface clothed with bundles of spines arranged in very regular rows, and so placed that each ray seems to be marked by three or four longitudinal furrows, crossed at regular intervals by transverse grooves. Under surface with short ambulacral plates and broad avenues. The largest specimens do not measure more than an inch across.

Affinities.—Unlike any fossil star-fish with which I am acquainted, and possibly not a member of this genus.

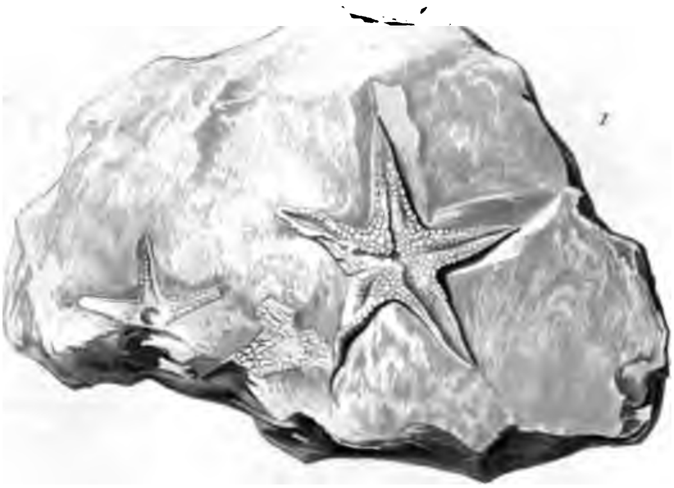
Locality and Geological Position.—Gregarious in Silurian (Ludlow) rocks at Pottersfell, near Kendal, in Westmoreland; first found by Mr. John Ruthven, and communicated by Professor Sedgwick. Its aspect reminds us of *Ophiura*.

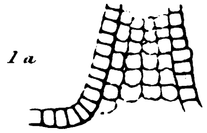
The materials afforded by the specimens hitherto procured of Silurian star-fishes are too imperfect to admit of more extended descriptions than those here given. They are sufficient, however, to enable us to pronounce with confidence on the tribe, and even genus, to which they have belonged, and to assert, without hesitation, that the several species described are distinct from one another. They are very interesting, inasmuch as they exhibit the earliest forms of the order *Asteriadæ*. Until within very few years past, it was supposed to have no palæozoic representatives; instead of which we now find them in the oldest fossiliferous strata. On the Continent palæozoic star-fishes have hitherto been noticed only in France, and much higher in the series of rocks than those now figured. In North America several forms have been found, apparently nearly allied to our own, and in rocks of silurian age. The genus to which I have referred these Silurian star-fishes is one of the most cosmopolitan of all the groups of the order, having representatives at present in arctic and antarctic, tropical and temperate, seas; the individuals are perhaps most abundant in northern regions. Some of the species have a considerable bathymetrical range.

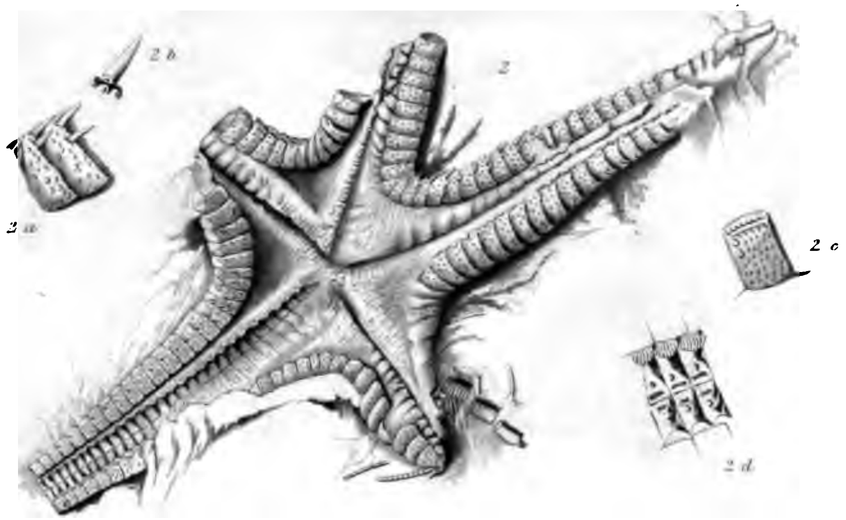
E. FORBES.

April, 1849.

ASTROPECTEN
(Oolitic)







1 ASTROPECTEN HASTINGIÆ *Forbes.*

2 — — PHILLIPSII *Forbes.*

BRITISH FOSSILS.

DECADE I. PLATE II.

OOLITIC SPECIES OF ASTROPECTEN.

[Genus ASTROPECTEN. LINCK. (Sub-kingdom Radiata. Class Echinodermata. Order Asteriadæ. Family Asteriæ.) Body stellate, few (five) rayed; no vent; rays flat on both sides, regular. Surface of body and upper sides of arms covered with paxillæ. Ambulacra with two rows of suckers, bordered by spines. Margins of the arms bordered by a double row of conspicuous plates.—The genera STELLARIA of NARDO, and ASTERIAS (restricted) of AGASSIZ, are synonymous.]

FIG. 1.

ASTROPECTEN HASTINGIÆ.

E. FORBES, in "Memoirs of the Geological Survey of Great Britain," vol. ii. part 2, p. 478.

DIAGNOSIS. *A. radiis brevibus, lanceolatis, acutis, lateribus rectis, angulis intermediis obtusis; ossiculis marginalibus quadratis, subæqualibus.*

Description.—Rays short in proportion to the rather broad flat body, triangularly lanceolate, with very straight sides and pointed extremities. The angles formed by their junction with each other and the body are obtuse. Their margins are bordered by regular series of nearly equal square plates, decreasing but slightly as they approach the apex. The length of each ray is about equal to the diameter of the disk. There are about 18 marginal plates in each row. The surface is covered by quadrate tessellations, indicating the arrangement of the plates, which probably, when the animal was alive, bore tufts of paxillæ or coronated spines. The specimen measures two inches in diameter.

Affinities.—The *Astropecten Phillipsii* is probably its nearest fossil ally, but the form and characters of its surface distinguish it conspicuously from any other British member of its genus.

Locality and Geological Position.—From oolitic beds (MARLSTONE) in Yorkshire, precise locality not known. In the cabinet of the Marchioness of Hastings, who has kindlv communicated it for description and delineation.

FIG. 2.

ASTROPECTEN PHILLIPSII.

E. FORBES, in "Memoirs of the Geological Survey of Great Britain," vol. ii. part 2, p. 478.

DIAGNOSIS. *A. radiis lanceolatis, lateribus rectis, angulis intermediis valde obtusis; ossiculis marginalibus oblongo-quadratis, spiniferis.*

Description.— Disk moderately developed, the arms being in length, compared with its diameter, as one and three-quarters to one. Rays slender, lanceolate, forming very obtuse angles at the junction with each other and the body. Margins of the rays bordered with oblong quadrate plates, which are studded with small tubercles, probably marking the points of attachment of paxillæ; on their edges also are a few scattered linear-lanceolate spines, which are not equal to the breadth of the plate. The ambulacra are bordered with semicircular combs of short spines. The plates composing the skeleton of the body appear to have been oblong. The marginal plates at the angles are narrow, as compared with those of the ray-borders. The diameter of the body is about an inch and two-twelfths. The length of the rays appear to have been about two inches one-twelfth; their breadth, near the junction of the rays with the body, is about seven-twelfths.

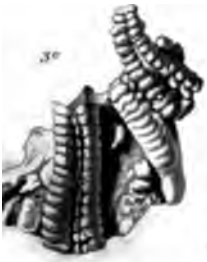
Affinities.—This beautiful species bear a striking resemblance to the recent *Astropecten aranciacus* and its allies. No fossil species of this genus, as yet figured, so clearly proves the true generic position of the extinct forms as this.

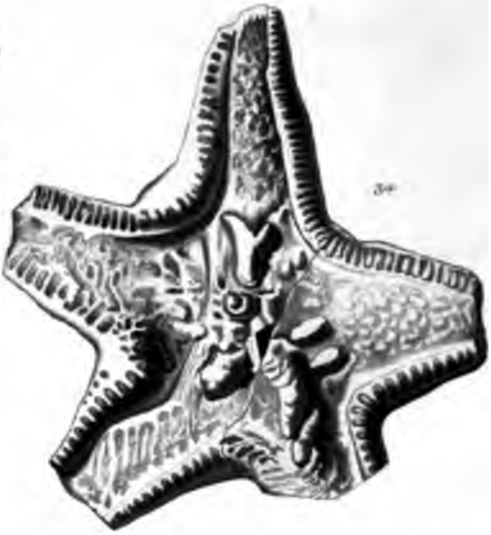
Locality and Geological Position.—Engraved from a drawing by Mr. J. Phillips of a specimen from the upper sandy beds of FOREST MARBLE, Hinton-lane-end, Yorkshire.

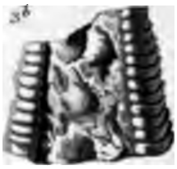
E. FORBES.

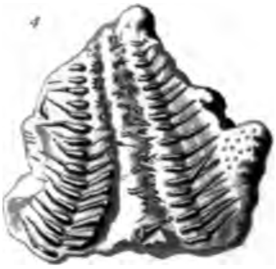
April, 1849.

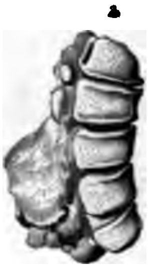
GONIASTER
ASTROPECTEN
(Tertiary)

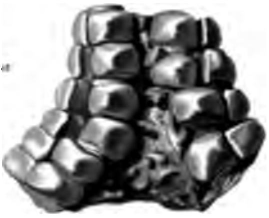


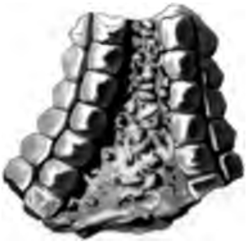


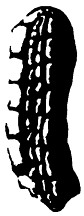


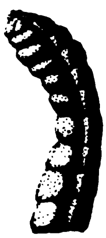












1 GONIASTER STOKESII *Forbes* 3 ASTROPECTEN CRISPATUS *Forbes*.

2 MARGINATUS *Forbes* 4 ARMATUS *Forbes*.

BRITISH FOSSILS.

DECADE I. PLATE III.

TERTIARY (EOCENE) SPECIES OF GONIASTER.

[Genus GONIASTER. AGASSIZ. (Sub-kingdom Radiata. Class Echinodermata. Order Asteriadæ. Family Goniasteriæ). Body pentagonal; a vent on the dorsal surface; disk much depressed, flat when dead; skeleton composed of tessellated plates, variously studded with granules, spines, and in many instances, pedicellariæ; rarely naked; margins bounded by two series of large plates; suckers biserial.]

FIG. 1.

GONIASTER STOKESII.

E. FORBES, in "Memoirs of the Geological Survey of Great Britain," vol. ii. part 2, p. 475.

DIAGNOSIS. *G. corpore pentagonali, angulis longè productis, lateribus profunde lunatis: ossiculis lateralibus superioribus disci oblongo-quadratis depressis eu convexiusculis, brachialibus quadratis tumidis, extrorsum abruptis; omnibus punctatis, inferioribus similaribus.*

Description.—Although I have never met with this very distinct species in a perfect condition, numerous fragments of greater or less dimensions give a very perfect notion of its size, form, and proportions. The body was pentangular, with angles greatly produced, and even attenuated at their extremities (fig. 1, *a.* and *d.*) into linear parallel-sided arms. The disk was flat, and, as well as the arms, bordered by a double series of subquadrate, steep-sided, somewhat nodular, nearly equal, thick marginal plates, the sides of which are quite equal in dimensions to the summits (fig. 1, *b.* and *c.*). These plates are coarsely but rather regularly punctated on their exposed surfaces. Their prominent nodular summits seem often as if subtruncated. The nodular convexity of each plate is placed towards its marginal extremity. The summits of the superior plates are more prominent than those of the inferior. Towards the prolonged extremities of the arms these nodulations begin to disappear; but the plates are always highly convex in their centres, so as to be strikingly distinct from each other, and to seem as if separated by a deep sulcus. The extremities of the rays are slightly swollen. They terminate in a distinct small semicircular ocular plate, bordered on each side by two (transformed marginals) small oblong oculars. The surface of the disk dorsally is covered with small irregular and pentagonal punctated flat plates, those towards the centre of the rays arranged in a more or less distinct series. Similar ossicula occupy the interambulacral spaces beneath. The ambulacra are bordered by quadrate stout plates of moderate dimensions, furrowed on their surfaces by three or four strongly marked longitudinal grooves, which are the lodging-places of small ambulacral spines.

This species must have attained considerable dimensions. The largest fragment figured (1, *b.*) would indicate a star-fish measuring at least 8 inches from the extremity of one arm to the end of that most distant, of which 2¼ inches would go to the disk. The marginal plates in this specimen measure 3-16ths of an inch across, and nearly as much high. The number of marginal plates in a full-grown specimen was probably about 28 on either side of each produced angle.

Locality and Geological Position.—Goniaster Stokesii occurs not unfrequently in the London clay of Sheppey. The specimens figured were communicated to the Geological Survey by Mr. Charles Stokes, and Mr. Bowerbank possesses a number of fragments of the same species. The peculiar convex, nodulose marginal plates, conspicuously distinguish it from any other tertiary star-fish.

FIG. 2.

GONIASTER MARGINATUS.

E. FORBES, in "Memoirs of the Geological Survey of Great Britain," vol. ii. part 2, p. 475.

DIAGNOSIS. *G. corpore?—ossiculis lateralibus disci magnis, oblongis, convexiusculis, rugoso-punctatis, marginatis; margine elevato.*

Description.—All that we possess of this species is a fragment, consisting of five superior and as many inferior marginal plates, which, however, present characters so distinct that they cannot belong to any other described tertiary star-fish. The superior plates are large, oblong, regularly declining outwardly, and low-sided. Their surface is but slightly convex, thickly punctured all over, and bordered laterally by a distinct elevated rim. The inferior plates are similar, but have even more elevated margins, and the rim is continued on them across their outer sides. What few body plates are visible are small and punctate. The fragment measures one inch and one-eighth in length. The largest plate is three-eighths of an inch in length, and less than two-eighths at its broadest part.

Locality and Geological Position.—The specimen is from the London clay of Sheppey, and was communicated to the Geological Survey by Mr. C. Stokes.

TERTIARY (EOCENE) SPECIES OF ASTROPECTEN.

[Genus ASTROPECTEN. Linck. (Sub-kingdom Radiata. Class Echinodermata. Order Asteriadæ. Family Asteriæ). Body stellate, few (five) rayed; no vent; rays flat on both sides, regular; surface of body, and upper sides of arms covered with paxillæ. Ambulacra with two rows of suckers, bordered by spines. Margins of the arms bordered by a double row of conspicuous plates.—The genera Stellaria of Nardo and Asterias (restricted) of Agassiz are synonymous.]

Fig. 3.

ASTROPECTEN CRISPATUS.

E. Forbes, in "Memoirs of the Geological Survey of Great Britain," vol. ii. part 2, p. 479—(icon.) Ansted, "Geology," vol. ii. p. 66, woodcut.

Diagnosis. *A. radiis late lanceolatis, attenuatis, angulis intermediis valde obtusis; ossiculis marginalibus anguste oblongis, numerosis, spiniferis; disco lato.*

Description.—Disk broad, rays lanceolate, broad at their bases, attenuated at their extremities, and forming very obtuse angles at their junctions with each other; the lanceolate portion of the arms is about one-fifth longer than the disk is broad. They are bordered by closely set oblong, narrow plates, very numerous, about 36 on either side of each ray in the largest specimen examined. These marginal plates decline outwardly. Those bordering the angles of junction preserve their dimensions. All the marginal plates bear at their exterior and superior edges short obtuse lanceolate spines. The inferior marginal plates are curved more regularly than the superior. The ossicula of the surface and framework of the disk are very irregular. The section of an arm shows that it was of inconsiderable thickness, and, from the peculiar shape of the marginal plates, edged at the sides. The ossicles bordering the ambulacra are of considerable dimensions. The extremities of the arms seem (judging from the fragment fig. 1, *c.*), to be much attenuated; but the plates bordering them preserved the proportions of those nearer the body. The breadth of the disk in the largest specimen I have seen is one inch four-twelfths. The rays are nine-twelfths of an inch broad at their bases. The marginal ossicles are four-twelfths of an inch broad, by less than one-twelfth long. The thickness of a ray is less than two-twelfths.

Locality and Geological Position.—In the London clay of Sheppey, where specimens are not uncommon. Those represented at figs. 3 *b* and 3 *c*, were communicated to the Geological Survey by Mr. Stokes. Fig. 3 *a* is a remarkably fine specimen, in the collection of Mr. Bowerbank.

FIG. 4.

ASTROPECTEN ARMATUS.

E. FORBES, in "Memoirs of the Geological Survey of Great Britain," vol. ii. part 2, p. 479.

DIAGNOSIS. *A. radiis lanceolatis, angulis intermediis valde obtusis, ossiculis marginalibus oblongis carinatis, extrorsum longè spinosis.*

Description.—The only fragment of this very distinct species is the greater portion of a single arm. It exhibits a lanceolate, depressed ray, with well-marked oblong carinated marginal ossicula, bearing towards their outer sides stout linear spines, equal in length to their breadth. The spines are set directly in connexion with the ridges. About 19 plates, and as many spines in a row, are preserved. Th fragment measures nine-twelfths of an inch in breadth at its base, an one inch three-twelfths in length; the spines and plates are respectivel about three-twelfths of an inch in length.

Locality and Geological Position.—This unique and curious specimen, contained in the collection of Mr. Bowerbank, is from the London clay of Sheppey.

E. FORBES.

April, 1849.

BRITISH FOSSILS.

DECADE I. PLATE IV.

PROTASTER SEDGWICKII.

[Genus PROTASTER. FORBES. (Sub-kingdom Radiata. Class Echinodermata. Order Ophiuridæ. Family Euryales.) Body circular, covered with squamiform plates; genital openings in the angles of junction of the arms beneath; arms (simple) formed of alternating ossicula.]

SPECIES UNICA. *Protaster Sedgwickii.* FORBES.

The remarkable fossil, of which, through the co-operation of Professor Sedgwick, we are enabled to give a figure, is unique of its kind, and has a peculiar interest in being the only representative of the tribe *Euryales* as yet discovered in the fossil state. I refer it to that tribe, and not to the *Ophiuræ*, with which at first sight it might be confounded, on account of the alternation of the ossicula of the arms, a conformation of which the *Astrophyton* and other genera of the former group exhibit examples, whilst it is never seen in any genus, as yet discovered, of the latter division. Like many other Silurian fossils, this one affords but imperfect materials for an investigation zoologically of its characters; such, however, as are to be seen in the specimens hitherto procured, are sufficient to enable us to assert with certainty that it is distinct both generically and specifically from any known starfish, whether recent or fossil.

Description.—The specimen figured consists of tolerably preserved impressions of the upper and under side of the disk or body, and of portions of the arms. The disk is circular, and shaped like that of an *Ophiura*. The arms are five in number, very narrow, equidistant, and similar.

The upper and under surfaces of the disk were covered by small, similar, more or less regular, polygonal or crescentic plates, imbricated in scale-fashion, and having punctated surfaces. Those of the under side of the body are smaller and more regular than those of the upper. The mouth is central, and rather small in proportion to the disk. The buccal apparatus is composed of ten parts or processes, arranged in pairs; half of each springs from the origin of each arm in a diverging manner, and meets the corresponding half to form a lanceolate tooth-like projection, deeply indenting the cavity of the mouth. Of how many separate ossicles each of the buccal processes was composed the specimen affords but very indistinct indication. They seem to affect a slightly falcate form at their extremities. The arms were composed of alternating somewhat quadrate ossicula, the sides of which were deeply indented superiorly, in order to form spiniferous crests. The spines were apparently short, and not equal in length to the length of an ossicle, obtuse, and few in a row. The under surfaces of the brachial ossicula were not indented laterally. The central portions of the upper surfaces of the brachial ossicles were hollowed out slightly, and the sutures between them deeply impressed. About twelve of the brachial ossicles were imbedded in the disk, and the parts of the dorsal surface of the latter, corresponding to the arms and central skeleton, do not present traces of scales, a feature seen in existing *Euryales*.

The dimensions of Professor Sedgwick's specimens are as follows :—

Breadth of disk, 0$\frac{8}{12}$ths inch.
Average breadth between the arms, 0$\frac{4}{12}$ths inch.
Breadth of an arm, at its junction with the body, 0$\frac{1}{12}$th inch.

Locality and Geological Horizon.—SILURIAN, from Ludlow rocks at Docker Park, near Kendal, Westmoreland (specimen figured), associated with Encrinites, and at Benson Knot, also near Kendal, in hard sandstones, full of characteristic Ludlow fossils. Collected by the Rev. Professor Sedgwick and Mr. John Ruthven.

EXPLANATION OF THE PLATE.

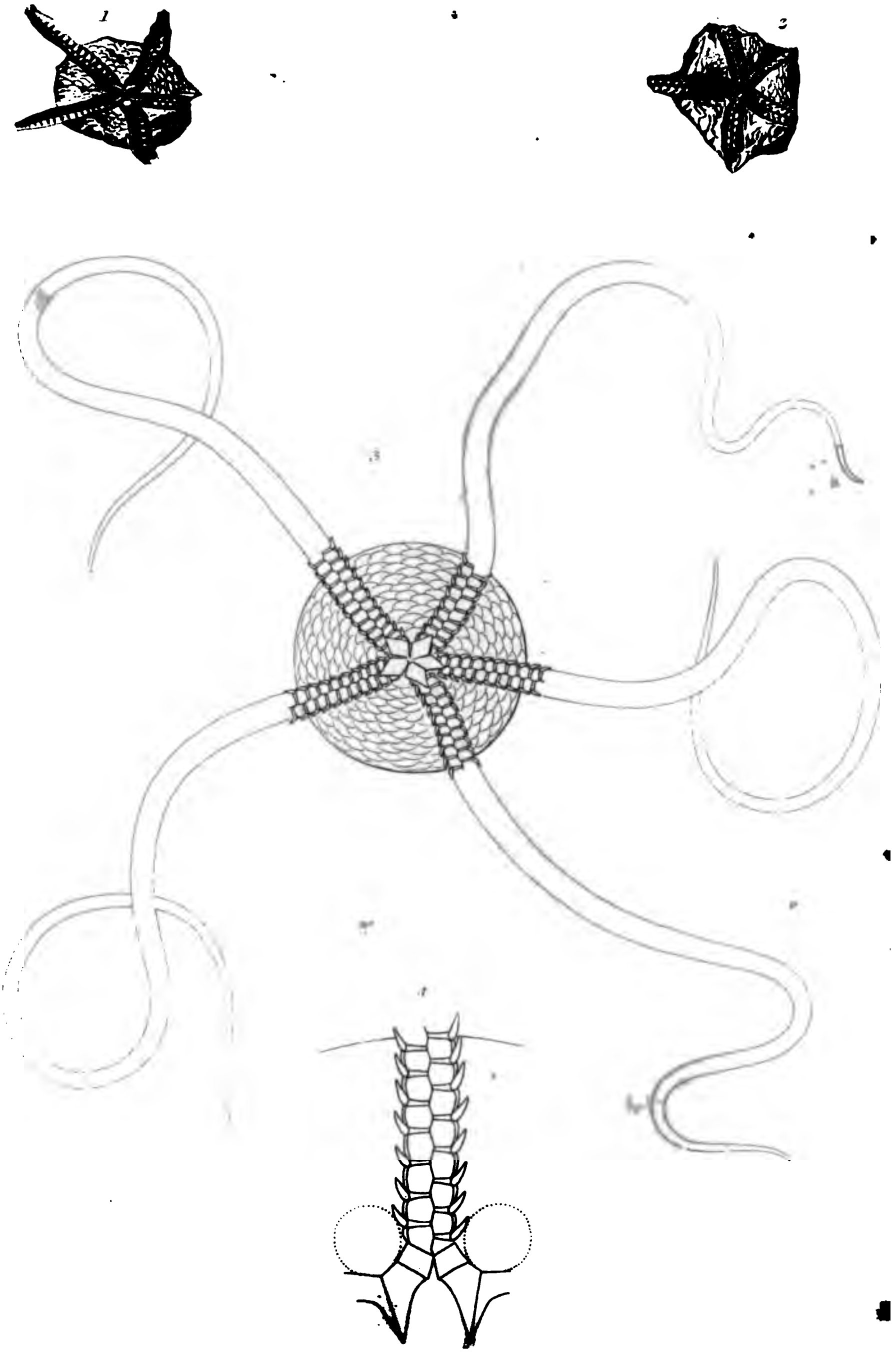
Fig. 1, under, and Fig. 2, upper side of the Docker Park specimen. Fig. 3. Restoration to show the probable form and appearance of the animal. Fig. 4. Diagram of base of an arm, buccal processes, and position of ovarian openings.

EDWARD FORBES.

April, 1849.

Geological Survey of the United Kingdom.

PROTASTER
(Silurian)



PROTASTER SEDGWICKII — *Forbes*.

BRITISH FOSSILS.

DECADE I. PLATE V.

SALENIA PERSONATA.

[Genus SALENIA. GRAY. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cidarites.) Body subglobose. Interambulacral segments very broad, bearing (few) primary imperforate tubercles; ambulacral areas very narrow, without primary tubercles; pores in single file; summit crowned with a complicated anal disk, composed of five ovarian and five ocular plates, and one supra-anal plate; anus excentrical; spines of two orders, the primaries long, slender, and cylindrical.—I regard the genera PELTASTES and GONIOPHORUS of AGASSIZ, as sections of the genus SALENIA.]

SYNONYMS. *Echinus petaliferus* (DESMAREST, MSS.), DEFRANCE, in the 37th volume of the Dict. des Sciences Naturelles, p. 101 (1825) [it had previously been clearly figured, but without a name, by PARKINSON, in the 3rd vol. of "Organic Remains," pl. 1, f. 12]. *Echinus areolatus*, KÖNIG. Icones Sectiles (1825), Fig. 100 (wrongly so named, not being the species of Wahlenberg). *Cidaris scutiger*, MUNSTER in GOLDFUSS, Petref. Germ., p. 120., pl. xlix., f. 4 (1826). *Salenia scutiger*. GRAY, Zool. Proc., part 3, for 1835, p. 58. *Echinus* (*Salenia*) *petaliferus*, ROEMER, Verst. Nord Deutschen Kreide-Geb. (1840), p. 30. *Salenia scutigera*, AGASSIZ, Echin. Suiss., ii., p. 89, t. 23, f. 1–5, and Monog. des Salenies, p. 12, t. 2, f. 1–8? *Salenia personata*, AGASSIZ (who states that it is the MSS. *Cidaris personata* of DEFRANCE), Monog. des Salenies, p. 7, f. 1–8. *Salenia petalifera*, AGASSIZ, Monog. des Salenies, p. 9, t. 1, f. 17–24. *S. personata* and *S. scutigera*, AGASSIZ and DESOR, Cat. Raisonné des Echinides, Annales des Sc. Nat., 3rd series, Zool., vol. vi., p. 341 (1846).

Probable variety. *Salenia gibba*, AGASSIZ, Monog. des Salenies, p. 13, t. 2, f. 9–16.

DIAGNOSIS. *S. testâ suborbiculari, dorso subdepresso, areâ anali magnâ, assulis lævigatis, suturis assularibus punctatis, punctis parvis circularibus seu triangularibus, margines assularum vix denticulantibus; areis interambulacralibus in medio late granulosis.*

In lettering our plate *Salenia personata*, we follow the nomenclature of the general catalogue of Echinidæ by Agassiz and Desor, but do so not without doubts of the justice of the nomenclature therein proposed, and can certainly offer no objections to the adoption of the specific appellation *petalifera*, in preference to the other names cited in our synonyms.

Parkinson gave a creditable figure of this curious sea-urchin, along with that of another and very distinct species (the *Salenia ornata* of Agassiz, MSS.), which has often been cited by mistake as identical with its companion. Defrance identified a French species with Parkinson's, and adopted Desmarest's manuscript name of *petalifera*. It would appear, however, from the statement of Professor Agassiz, in his monograph of *Saleniæ*, that Defrance himself used the name *personata* for a fossil which the distinguished naturalist of Neuchatel regards as the type of the species before us. The *Salenia* figured by Goldfuss, under the name of *Cidaris scutiger*, does not seem to me to differ essentially from our British species, and I cannot see those distinctions which Agassiz has pointed out between it and the one we figure, at least in Goldfuss's excellent representation; though that figured by Agassiz himself as *scutiger*, certainly presents differences, especially in the indentations of the sutures of the anal plates, which may indicate a distinct variety if not species.

Description.—Body subglobose, depressed above, divided into five equal portions by the five series of ambulacral plates, which stand out rather more prominently than the interambulacrals. Anal disk broad and slightly convex in some specimens, much more so than in others; its outline is slightly sinuous. The centre of it is occupied by the supra-anal plate, which is of a hexagonal shape, broader than long, prominent dorsally and centrally, excavated in form of crescent to make the anterior margin of the anus. In front of it is the anterior ovarian plate, lyrately oblong, longer than broad, broadest posteriorly and centrally, perforated in the centre by a large ovarian pore. The lateral ovarian plates are similar in form, but rather shorter. All have their frontal or free margins prominent in the centre. The posterior ovarian plates resemble the others, except that their superior and inner angles are truncated crescentically, and strongly margined, to go towards the formation of the anal rim. They are all perforated by ovarian pores, more or less marginated. In many specimens the anal rim partially encroaches on the posterior ovarian pores. The ocular plates are of much smaller dimensions, transversely and subtriangularly oblong, their inner sides forming the prominent portions of the triangle, and their frontal margins the bases. Their inner sides unite with the inferior and lateral parts of the neighbouring ovarian plates, the superior and lateral parts of which unite with each other, and their superior margins with the supra-anal plate. At the angles of junction of every three plates is a deep excavation or punctation, and another in the centre of the line of union between every two plates. Thus there are nine punctations around the borders of the three anterior ovarian plates, six around each of the posterior ovarians, and three around each of the oculars. The pits at the junction of three plates are triangular, those at the junction of two, circular. They are never prolonged as linear notches into the substance of the plates. The surfaces of the latter, in a few rare specimens, exhibit indistinct indications of radiated ribbing. The anus itself is subcircular, slightly inclining to transversely oval. It is bordered by a very prominent rim, formed of the elevated margins of the posterior ovarian and supra-anal plates. The sutures of parts of the rims appear in many specimens as if consolidated.

The ambulacra are composed of two slightly sinuous poriferous grooves, and separated by the ambulacral spaces. The latter are narrow, and through a great part, of nearly equal dimensions. Each ambulacral plate bears a marginal tubercle, and one or two smaller ones on its inner or central side. The marginal tubercles, being nearly of an equal size, form a closely ranged border to the ambulacral spaces; the interspace between the borders is occupied by alternating tubercles of smaller dimensions. The poriferous avenues are depressed and very narrow. The pairs of pores are ranged in single file, except immediately near the mouth, where they are double and triple ranked. Each pore is separated from its fellow by a rather prominent ridge. The interambulacral spaces are, in their centres, three times the breadth of the ambulacrals. They are composed of few plates, some of which bear areolated spaces, surrounding primary spiniferous tubercles. These are borne on elevated prominences, which form a dentated margin around their bases. The primary tubercles are not equal in diameter to the breadth of the rings surrounding them. The edges of these circles are bordered by a rather scattered series of secondary tubercles, usually about seven in number. Of the primary tubercles and their areolæ, there are three most conspicuous on each interambulacral area, two to the left, and one, nearly centrical, on the right side. Down the centre of each interambulacral area runs undulating an elevated, but plane space, occupied by tertiary tubercles, closely and rather irregularly set, bordered by the secondary tubercles which bound the rims of the areolæ. There are no tertiary tubercles in the spaces between one areola and another of the same vertical series.

The mouth is round, and not very large, as compared with the diameter of the body. Its margin is deeply notched opposite each poriferous suture, and sinuated in the interambulacral intervals. It is bordered all round by a more or less thickened rim.

In a well-grown specimen there are about 38 pairs of pores in each series, and about 18 bordering secondary tubercles on each side of an ambulacral space.

As yet the spines are unknown.

Dimensions of a well-formed example.

Diameter	$0\frac{9}{12}$	unc.
Height	$0\frac{5}{12}$	,,
Breadth of anal disk	$0\frac{6}{12}$	,,
Breadth of an ambulacral area	$0\frac{1}{12}$	,,
Breadth of an interambulacral area	$0\frac{4}{12}$	,,
Breadth of mouth	$0\frac{2}{12}$	,,

Locality and Geological Position.—Plentiful in the UPPER GREENSAND at Warminster. (Survey Collections.)

Foreign Distribution.—In the Craie chloritee of France, Bavaria, and Minorca, and Hills-conglomerat of North Germany.

EXPLANATION OF THE PLATE.

Figs. 1, 2, and 3. Upper, under, and lateral views of a Warminster specimen. Fig. 4. Genito-anal disk. Fig. 5. Two ambulacral areas, and one interambulacral greatly magnified. Fig. 6. Arrangement of the pairs of pores near the mouth. Fig. 7. Ambulacral plates and pores. Fig. 8. Relative arrangements of ambulacral and interambulacral plates. Fig. 9. An interambulacral plate, with its tubercles. Fig. 10. A primary tubercle seated on its pedicle, with the surrounding secondary tubercles, seen in profile.

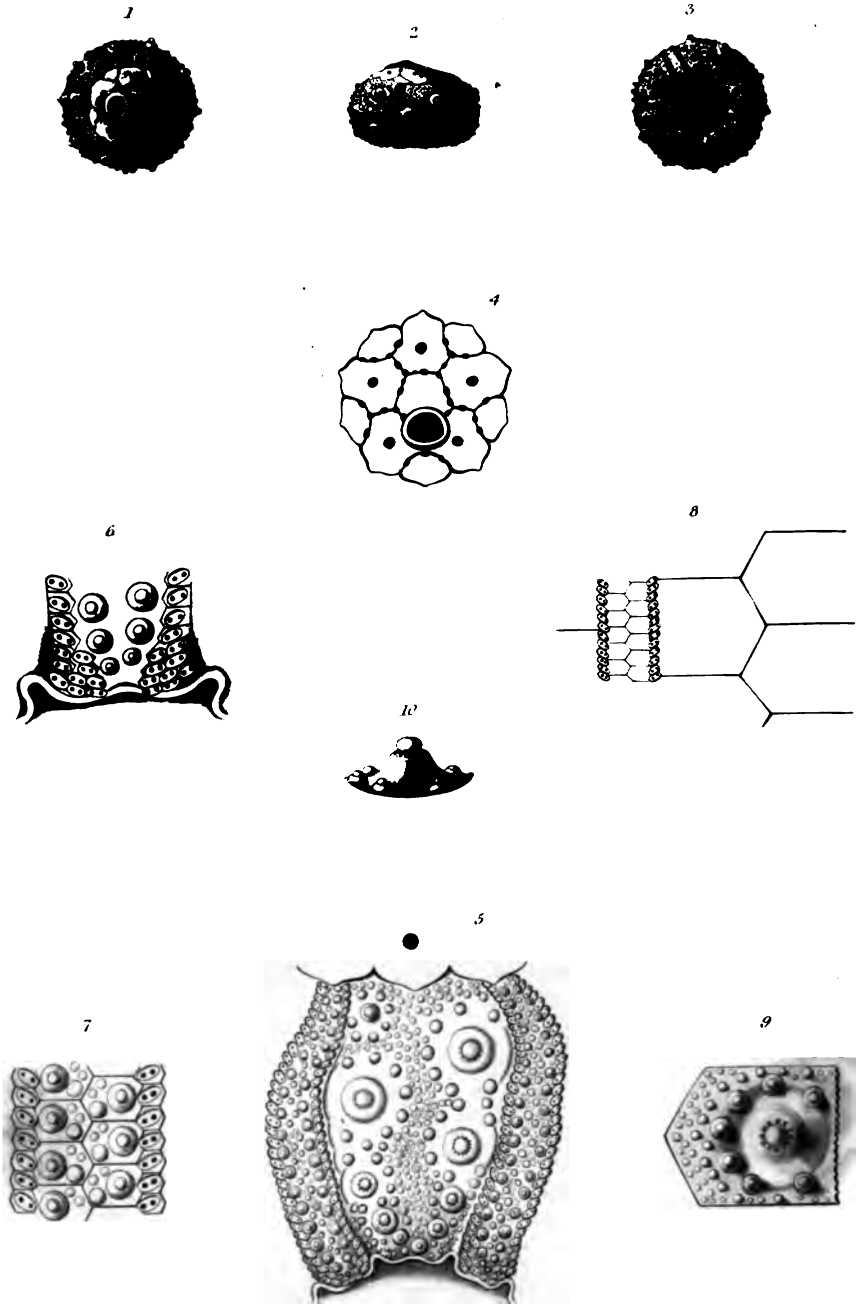
E. FORBES.

April, 1849.

DECADE I. PL. 5.

Geological Survey of the United Kingdom.

SALENIA
(Cretaceous.)



SALENIA PERSONATA — *Defrance.*

BRITISH FOSSILS.

DECADE I. PLATE VI.

ECHINUS GRANULOSUS.

[Genus ECHINUS. LINNÆUS. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cidarites.) Body more or less spherical; ambulacral and inter-ambulacral segments developed, bearing on their plates tubercles of various sizes; anus centrical, not furnished with regular calcareous valves, surrounded by a circle of five ovarian and five ocular plates, all perforated; ambulacral avenues composed of pairs of pores ranged in series of three or more; spines of one order.]

SYNONYMS. *Echinus granulosus*, MUNSTER, in GOLDFUSS, Pet. Germ., p. 125, pl. 49, *f.* 5 *a*, *b*. *Echinus Bennettiæ*, KŒNIG, Icon. Sect., p. 35. *Echinus granulosus*, GRATELOUP, Mem. Ours. foss., p. 82. *Echinus granulosus*, DUJARDIN, in second edition of LAMARCK, An. sans Vert., vol. iii., p. 372. *Arbacia granulosa*, AGASSIZ, Cat. Syst., p. 12. MORRIS, Cat. Brit. Fos., p. 48. AGASSIZ and DESOR, Cat. Rais. des Echinides, Ann. des Sc. Nat., 3rd Ser., vol. vi., Zoologie, p. 356.

DIAGNOSIS. *E. assulis numerosis, centro-lateralibus angustissimis, dense tuberculatis; tuberculis primariis parvis æqualibus, regulariter in seriebus horizontalibus dispositis; poris ambulacralibus in seriebus triplicibus verticalibus et ut in ordine simplici dispositis, sed prope orem verè subobliquis.*

This pretty and plentiful little fossil urchin was first figured as British, though very imperfectly, by Mr. König, in his "Icones Sectiles," under the name of *Echinus Bennettiæ*, and as a German species, by Goldfuss, under the name of *Echinus granulosus*, given it by Munster. The figure and description in the "Petrefacta Germanica" are so complete, that we cannot hesitate to adopt the name by which this fossil is known to geologists and collectors.

In recently published catalogues it figures as a species of *Arbacia*, and in the "Catalogue Raisonné des Echinides" of Agassiz and Desor heads the second type of that genus—the section in which the tubercles are described as uniform all over the surface of the shell. *Echinus monilis*, a species bearing considerable resemblance to that before us, and well known both in the fossil and recent state, having been found in French and British upper tertiaries, and by myself alive in the Mediterranean, is placed by the authors quoted at the head of their first type of the genus. *Arbacia* is a group of *Echinidæ*, founded by Mr. J. E. Gray in 1835 (Zool. Proc., part 3, p. 58), for a section of the genus

Echinus, in which, according to the founder, the body is depressed, the ambulacral areas very narrow, the ambulacra narrow, straight, and containing pairs of pores ranged in a single row, the ovarian and interovarian plates middle-sized, and the anus covered by four valves. The types of this genus, as cited by its founder, are the *Echinus pustulosus* of Lamarck and the *E. punctulatus* of the same author. The genus is a good one, though its characters were partially misunderstood by its founder, for the ambulacral pores are not uniserial. It presents a very peculiar and undescribed structure of the ocular plates. The characters of *Arbacia*, as given by Agassiz, are, however, altogether different from those just cited, for he confines it to "small subspherical urchins, having the test covered by numerous little smooth-based imperforate tubercles, ranged in numerous rows on the interambulacral areæ, and sometimes also on the ambulacral ones. Pores ranged in a simple series. Mouth circular, without deep notches. Genital apparatus narrow and ring-shaped." All the species enumerated in his synopsis are cretaceous or tertiary fossils. The *Arbaciæ* of Gray are transferred to *Echinocidaris* of Desmoulins, a genus synonymous with *Arbacia*, in the sense of its founder's definition. In that sense the several fossils enumerated under *Arbacia*, in the "Catalogue Raisonné des Echinides," cannot be so called,* for neither *Echinus monilis* nor *Echinus granulosus* partake of its characters. They are, in fact, true *Echini*, as I have elsewhere shown, when describing the living *E. monilis*, and am prepared to prove, with respect to the fossil *E. granulosus*, that neither the degree of convexity of shell, or abundance of spiniferous tubercles, or the arrangement of the pores (which are not in simple series), or the structure of the mouth or of the genital apparatus, can warrant the constitution of a generic group distinct from *Echinus*, using the word in its restricted sense, for the species in question.

Description.—The body varies in shape from sub-globular (as in fig. 2), to sub-conical (as in fig. 5), and to the unarmed eye resembles a miniature melon, studded over by minute uniform tubercles, and divided into five broad and five narrow segments, by narrow, depressed, punctured furrows, radiating above from a circle of apical plates, surrounding a central perforation, and converging below towards a much larger central circular orifice.

The ambulacral and interambulacral segments are composed of similar polygonal plates, very numerous. Those of the former are shortly oblong, those of the latter very narrow in vertical dimensions. All are covered by small, imperforate, thick-set primary tubercles, separated by minute secondary ones. The former alone were probably spiniferous, the latter probably indicate the position of the bases of pedicellariæ. The tubercles of both the ambulacral and interambulacral plates are similar, but on the former the secondary granulations are more numerous than on the latter. On the ambulacral plates the primary tubercles are ranged in a single line, transverse to the form of the test, giving the surface a lineated aspect. In some specimens they fall so directly under each other, as to give the appearance of vertical as well as horizontal granulations. There are about eight or nine primary tubercles on a central interambulacral, and three on an ambulacral plate. The line of junction of the two series of interambulacrals, and sometimes of the ambulacrals in each segment, is not unfrequently strongly marked. In such specimens the interambulacrals occasionally exhibit a tendency to vertical carination. Opposite each plate are three pair of pores in the ambulacral sulci, which are very narrow, and run almost straightly down the sides. The number of pores are a multiple of the number of plates by three. The pores appear to form a single series, but are not really so arranged, as we may convince ourselves by tracing the poriferous avenues to their junction with the mouth. As they approach that orifice they exhibit a tendency to form oblique rows, and at length definitely fall into ranks of threes (fig. 11). Hence the distinction between the genus *Arbacia* (in the sense used by writers on fossils) and *Echinus*, founded on the arrangement of the pores in a single series in the former, and in many series in the latter, is a mistake. This is quite as plainly seen in the so-called *Arbacia monilis*, where the pairs of pores are ranked in fours so distinctly all over the shell that it is strange such an arrangement should have been overlooked. In an undescribed green-sand urchin, brought from Portugal by Mr. Daniel Sharpe, the general aspect of the shell, the arrangement of tubercles, &c., so closely resemble the species we are describing, that at first sight they seem identical, but when the poriferous avenues are examined, the pairs of pores are seen to fall into very oblique and unmistakable ranks of threes throughout. The mouth is circular, rather small in proportion to the base, and very slightly notched opposite the ambulacral furrows. The anal and ovarian circle is small in proportion, being about two-fifths of the breadth of the mouth. The diameter of the ovarian and anal circle is to the mouth as the maximum breadth of the ambulacral to that of the interambulacral segments. The anus was not protected by definite and symmetrical testaceous valves. The ovarian plates are subtriangular, and perforated in their centres by a conspicuous oviducal pore. One of them is in some specimens slightly larger than the rest, and exhibits traces of a madreporiform tubercle. The ocular plates are small, and angularly reniform; the perforation for the ocelli is in the central angle of their excavated and outer margins, thus presenting a slight abnormality of position. The ovarian circle is exactly the diameter of the widest and most central portion of the ambulacral segments, as the mouth is of the interambulacral. I have not met with the spines. The shell is thin.

The largest example I have seen measured eight-twelfths of an inch in diameter. The proportion of elevation to breadth varies in almost every individual, and is quite as variable as it is well known to be in the recent *Echinus*. The specimen mentioned was five-twelfths of an inch in height, and had 34 plates in vertical succession, composing each half-segment, and consequently there were above 100 pairs of pores in each avenue, indicating as many suckers.

In four examples from the same locality the proportion of diameter to height was respectively as 17 to 10, 15 to 11, 12 to 11, and 12 to 8. The *Arbacia conica* of Agassiz, of which we have no other description than that it is near *granulosa*, "Mais plus haute et plus conique," cannot, therefore, be regarded as a species, or even as a marked variety. With the variations of proportion the shell becomes more or less globular.

Locality and Geological Position.—Very abundant in the upper green-sand of Warminster. (Survey Collection.) Chute Farm, Wilts.

On the Continent it was first noticed in the upper green-sand of Regensburg, in Bavaria. It occurs in France in the Craie chloritee of l'Isle d'Aix, Le Mans, and (*Arbac. conica*) Calvados.

The *Echinus pelos*, from the Neocomian of the canton of Neuchatel, is its nearest ally and predecessor.

M. Grateloup states that it is found at Dax, and in the white chalk of Pouillon.

EXPLANATION OF THE PLATE.

Fig. 1. A specimen of ordinary dimensions, seen from above. Fig. 2. The same from the side; and Fig. 3, from below. Figs. 4, 5, and 6. Outlines of specimens of different ages, showing extreme variations of form. Fig. 5 appears to be the *Arbacia conica* of Agassiz. Figs. 7 and 8. Upper and under magnified views, showing the arrangement and articulations of the plates, which, for better display, are partly represented without their tubercles. Fig. 9. The circle of ovarian and ocular plates. Fig. 10. Ambulacral and interambulacral plates, with portions of avenues taken from the central portion of the side, showing the arrangements of the primary and secondary tubercles. Fig. 11. Portion of avenues near the mouth, showing that the apparent single arrangement of the pairs of pores is deceptive, and that they are really three-ranked. Fig. 12. One of the primary tubercles, seated on its elevated base, and surrounded by secondary granules.

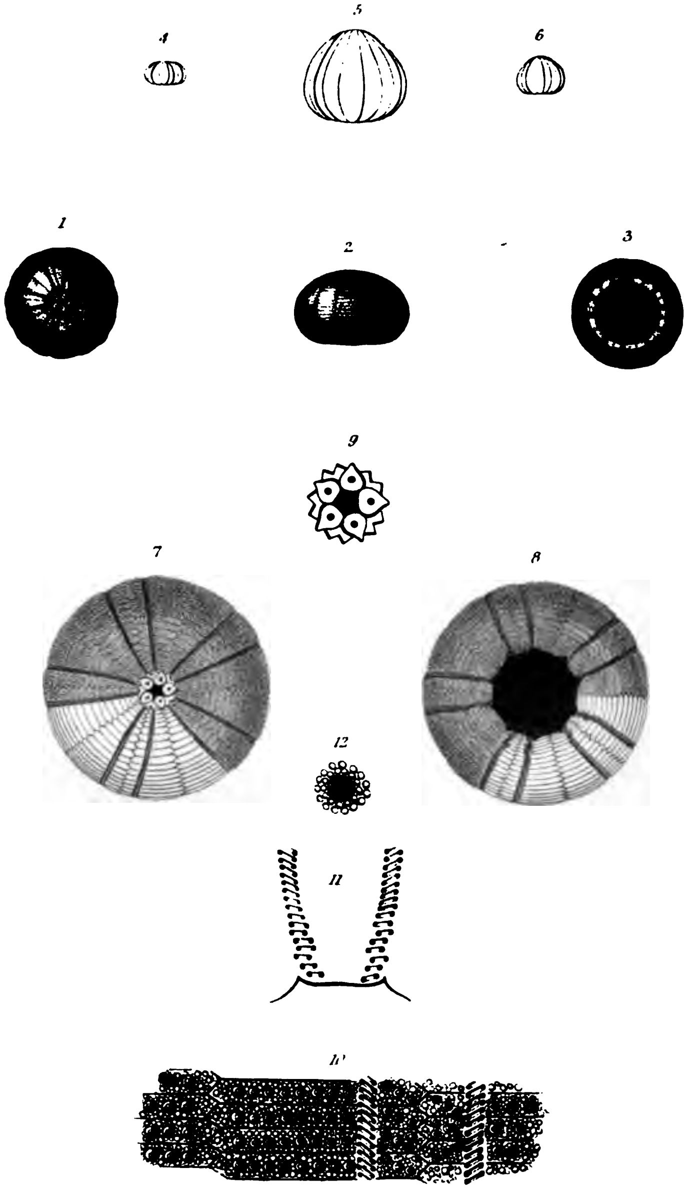
E. FORBES.

April, 1849.

DECADE I. PL.

Geological Survey of the United Kingdom.

ECHINUS
(Cretaceous.)



ECHINUS GRANULOSUS. *Munster*

Baily del.

E. Forbes direx^t

BRITISH FOSSILS.

Decade I. Plate VII.

GALERITES (DISCOIDEA) SUBUCULUS.

[Genus GALERITES. Lamarck. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cassidulidæ.) Body more or less hemispherical, always tumid; ambulacra simple, continuous, radiant; mouth central, inferior; anus inferior or submarginal; tubercles perforate.]

[Sub-genus *Discoidea*. Body hemispheric, circular, flat-based; tubercles in regular series; inside strengthened by strong ribs.]

Synonyms. ***Discoides subuculus***, Klein, t. 14, f. 57 (copied in Enc. Meth., pl. 153, f. 14–17). *Echinites subuculus*, Leske. ap. Klein, p. 171. ***Echinus subuculus***, Gmelin, p. 3183. *Galerites rotularis*, Lamarck, An. sans Vert. iii., p. 309. ***Discoides subuculus***, Parkinson, vol. iii., p. 21, pl. II., fig. 7. ***Galerites subuculus***, Goldfuss, p. 129, pl. 41, f. 2. ***Discoidea subuculus***, Bronn, Lethæa, p. 615, t. 29, f. 29. ***Discoidea rotularis***, Gray, Ann. Phil., 1825; Agassiz, Prod., p. 186. ***Discoidea subuculus***, Desor, Mon. Gal., p. 54; Agassiz and Desor, Cat. Rais. des Echin. Ann. Sc. Nat., 3rd Ser., t. 7, p. 146. *Galerites* (*Discoidea*) *subuculus*, Roemer, Nord Deutsch. Kreide Geb., p. 31; Müller, Aach. Kreideformation, p. 8.

Diagnosis. ***G.* (*Discoidea*) *parva, hemisphærica, plus minusve convexa, marginibus rotundatis, ventre plus minusve excavato; areis ambulacralibus centro-lateralibus dimidium arearum interambulacralium adæquantibus; ano magno; assulis ambulacralibus* 4 *ad assulam interambulacralem.***

Var. α. *Ambitu orbiculari, marginibus compressiusculis.*—***D. subuculus auctorum.*** Loc., ***in arenâ viridi.***

Var. β. ***Ambitu subpentagonali, marginibus rotundatis.*—*D. infera*,** Desor, Cat. Rais., p. 147? Loc., ***in cretâ albâ.***

A wretched figure in Plott's "History of Oxfordshire," (1677, p. 140, pl. 8, f. 9,) is supposed to be the first representation of this fossil. It is described by Plott, as a "Button-stone from Teynton, a mere production of nature, except we should take it for a new sort of echinite not yet discovered, which is wholly left to the reader's choice." Lister, in his book, "De Lapidibus Turbinatis," copies it as an echinite. Klein quotes the same figure for his *Discoides subuculus*, and gives figures himself (t. 14, f. 57) sufficiently recognisable. It is the type of the genus *Discoides* of Klein, separated by that author from his genus

Conulus, of which *Galerites albogalerus* is the type. Leske, in his edition of Klein (p. 171), reunites the genera, and describes the species in detail. He remarks, however, that the figure of Plott is too doubtful to be quoted as a representation of the *Echinites subuculus*, and that it seems rather to represent a madrepore. He exercises more critical judgment in the examination of his references than is shown by some of his successors; who, indeed, whilst quoting him, do not appear to have read his text. He rejects, also, a figure in Langius, whose work I have not been able to see. Since then it has been figured, seldom very well, by Alexander Brogniart, from French specimens, by Goldfuss and Bronn from German examples, and by Parkinson (badly) from English ones. The latest and best representation is that given in the "Monograph of Galerites," by Desor.

Description.—The body exhibits an outline exactly orbicular, or occasionally exhibiting a very slight tendency to a pentangular contour. It is regularly convex above, but to a greater or less degree in different specimens, exhibiting every gradation of variation, from prominently conical to subdepressed. The upper surface is divided into five broad and five narrow segments, by the avenues of pores, which regularly radiate from the ovarian circle crowning the summit. The under surface is more or less flattened, with more or less rounded margins, and a more or less concave centre, in the middle of which is the circular mouth, and between the mouth and the posterior margin a large oblong anus.

The interambulacral segments are, in their widest part, rather more than twice the breadth of the ambulacrals. The plates composing their dorsal portion rarely exceed 13 in number in full-grown specimens, of whatsoever shape. The central ones are broader than long; those near the summit more and more nearly of equal dimensions in both directions: but whatever be their horizontal diameter, their vertical measure is nearly the same in all. Their surfaces are thickly studded with minute secondary granules, more or less regularly arranged, often appearing as if placed in horizontal series. Each plate exhibits a more or less distinct subcentral carination, so that in many specimens the interambulacral spaces appear as if partitioned by two diverging keels, one on each side of the line of junction of the interambulacral plates. In the line of carination each plate bears a prominent primary tubercle, and in an horizontal row with it, towards the interambulacral suture, are two or three others similar in size and shape; whilst on the other division of the plate, towards the avenue, two or more similar tubercles are also seen, placed in two oblique series with reference to the position of the tubercle on the carina. Consequently, on the avenue side of each carina, in the interambulacral spaces, the tubercles appear as if arranged in ascending oblique rows; and, on the centro-sutural side, in horizontal rows. Towards the margin the tubercles become more numerous, and sometimes less regularly disposed. The plates of the ventral surface are of equal vertical dimensions with those of the dorsal, and similarly ornamented. In well-grown specimens they are from six to eight in number. The suture of articulation of the interambulacral plates with each other varies in degree of straightness, or zigzag, in different specimens; and is most nearly straight when the dorsal surface is least depressed.

The ambulacral plates are very numerous and narrow, four of them going to the vertical diameter of an interambulacral plate. They are closely studded with granules like the latter, and each bears usually one primary tubercle. These tubercles are so arranged that they do not fall in direct vertical rows, but form oblique series of threes, or, as in some specimens, where alternate plates have their primary tubercles suppressed, in twos. On the ventral surface the tubercles are similar, except that they are often larger than those on the dorsal. Each plate corresponds to a pair of pores in the ambulacral avenue. The avenues are impressed, quite straight, and have the pairs of pores in regular succession, single file. They have a tendency to become obsolete near the mouth. The two pores of each pair are obliquely set with respect to each other. As there are about 21 interambulacral plates in each vertical series, from mouth to apex, in an ordinary specimen, the number of ambulacral plates will be about 84, and that of pairs of pores the same. The primary tubercles are placed on elevations in areolated spaces, and are invariably perforate.

The mouth is circular, and occupies the centre of the more or less concave ventral surface. Its breadth is rather less than the distance from its side to the outer margin. The anus occupies a considerable part of the ventral space between the two postero-lateral ambulacra and the margin. It is of an ovate form, its greatest dimensions being in the line of length, *i. e.*, from the mouth towards the margin, and its outer extremity is slightly pointed.

The apex is composed of the combined ovarian and ocular plates, and is in great part occupied by a madreporiform tubercle. The posterior ovarian pore is undeveloped, as in all the genus. The ocular pores are distinct.

Casts of the interior differ from the external shape of the body in exhibiting ten deep notches around the margin, extending to the mouth on the ventral surface, and ceasing at about a third of the height on the dorsal. Five of these unite near the mouth, and five continue singly to it. The centre of the prominent interspaces of the latter is marked by a shallow groove. The groove corresponds to the line of suture of the ambulacral plates, and its prominent sides to the avenues of pores. The ten deep notches are caused by as many internal ribs, which spring from the inner sides of the mouth, and run up the wall under the carinated portion of each series of interambulacral plates.

Dimensions and Varieties.—The ordinary breadth of this species is about 7-12ths of an inch. The proportions of the breadth to the height are very variable, even in specimens from the same locality, as may be exemplified by the following instances of upper green-sand specimens from Warminster: 1st specimen, breadth to height (in millemetres,) 14 : 10; 2nd, 14 : 8; 3rd, 12 : 8; 4th, 11 : 9; 5th, 10 : 8. This variation in degree of elevation is accompanied by very great variation in rotundity of margin and convexity of base. The most rounded specimens are those of a variety which occur in the white chalk. It combines rotundity with height, and has usually fewer primary tubercles than are seen in ordinary specimens. In no essential respect, however, does it differ from the green-sand form, and may be paralleled exactly by exceptional specimens of the latter.

In the "Monograph of Galerites," by Desor, and in the "Catalogue Raisonné des Echinides," four species of *Discoidea* allied to *subuculus*, are enumerated. The first of these, *Discoidea minima* (Agassiz), founded on a single example from the chalk marl of France, seems, judging from figure and description, to be only one of the less conical forms of the young of the species, such as not uncommonly occur at Warminster. The second, *Discoidea pisum* (Merian), unfigured, is said to be exactly like *D. minima*, and only distinguishable from it and *subuculus* by having distinctly perforate primary tubercles. This, however, is the case with well-preserved specimens of every *Discoidea*, and is a generic, not specific, distinction. The third, *Discoidea turrita* (Desor), described and figured from a single example, is represented as proportionally higher than *subuculus*, and differing in having several vertical series of primary tubercles equally prominent on the interambulacral spaces, and not two only, like those on the keels. But we find in British specimens these characters combined or not, and occurring in individuals not uncommonly, besides exhibiting every degree of transition into the ordinary features of the species. The fourth is merely named in the "Catalogue Raisonné;" it is the *Discoidea infera* (Desor), from the white chalk of Fécamp, said to be very near *subuculus*, but differing in having the primary tubercles conspicuous only on the ventral surface. Specimens of our variety from the white chalk —the most distinct looking form of all—yet certainly not essentially so, accord very well with the brief and insufficient notice given in the catalogue.

Allied Species.—Although I have little doubt that the several so-called species just mentioned are only slight varieties, if as much, of *subuculus*, there is, however, a white chalk *Galerites*, of the section *Discoidea*, in the cabinet of Mr. Dixon, of Worthing, and figured by that gentleman in his forthcoming work on the geology of Sussex, which, whilst very closely allied to the species here described, presents certain characters which are not present either in green-sand specimens of *subuculus*, or in those from the white chalk itself. In form and size it resembles ordinary examples of that species, and the proportion of the ambulacral to the number of interambulacral plates is the same, nor does the granulation of the surface materially differ. The proportions of mouth and anus, and their dimensions, as compared with the entire ventral surface, are so very different, and characters founded on such differences appear to be so constant in this genus, that I feel bound to regard it as distinct. The mouth, instead of being (as in *subuculus*) nearly equal in diameter to the distances between its sides and the margin of the inferior surface, is scarcely half that size, and the anus, instead of occupying the greater part of the space between the mouth and the margin, fills less than a half of it; consequently the appearance of the base, with its perforations, is materially different, and as I can find no specimens presenting intermediate characters among those of the *subuculus*, either from green sand or chalk, I feel bound to consider this a distinct species, and have named it *Galerites* (*Discoidea*) *Dixoni*.

In the preceding account of *Galerites subuculus*, and in my notes on *Galerites subcylindrica* (Dec. i., pl. viii.) I have considered the *Galerites rotula* of Alexander Brongniart (Geognosie des Terrains de Paris, pl. 9, f. 13, A. B. C.) as identical with the former species, and his figure as a representation of a large specimen of it. I am induced to do so on account of the evident manner in which the subcarination of the halves of the interambulacral spaces are indicated in his figure (13 A.), whilst the inferior surface is represented as thickly covered with nearly equal tubercles. Unfortunately no figure of the anus is given, to enable us to decide with more certainty. On one of the figures an appearance as if of a supramarginal anus is indicated, and this no doubt has led M. Charles Des Moulins to regard it as a *Pyrina*, and to name it *Pyrina rotula*. If his view of its characters be correct, it has certainly nothing to do with the section *Discoidea*. Agassiz has, however, considered Brongniart's figure as the type of his *Discoidea rotula*—a very different species, and which, since our note of *Galerites cylindricus* was put in type, I am still more inclined to identify with the *Discoidea* there described, from the junction beds of the chalk and green sand, and of which Mr. Morris has afforded me opportunities of seeing a number of specimens, of different ages, from Charldon, in Dorsetshire. An examination of them, and of their casts, confirms me in my opinion of the propriety of uniting *Discoidea rotula* of Agassiz, and *Discoidea favrina* of Desor, since the character of the notching on the casts varies in different specimens. *Discoidea conica*, of Desor, I take to be the same species, assuming a more pentagonal form, a variety apparently not uncommon among British examples. The *Discoidea rotula* of Mr. M'Coy, from the upper chalk, must surely be something quite distinct. The young of the species, to which I would reserve the name *Galerites* (*Discoidea*) *favrinus*, might be confounded at first sight with *subuculus*, but is very different on close examination. It presents an orbicular outline, with a strong tendency to become pentagonal. It is regularly convex above, with more swelling sides, and, consequently, a flatter summit than *subuculus* has, whilst its margins are often nearly as much rounded as in that species. The interambulacral segments are, in their widest part, thrice the breadth of the ambulacrals, and the ambulacra widely diverge from each other when proceeding from the summit, characters which will at once distinguish between this form in its young state and *subuculus*.

Locality and Geological Position.—It abounds in the UPPER GREEN SAND of Warminster, Chute Farm, Wilts; in the junction bed of GREEN SAND and CHALK MARL at Maiden Bradley, Wilts. (Survey Collections.) LOWER CHALK, Weymouth (Morris). In the WHITE CHALK of Kent, but not so common. Morris (Cat. p. 52) mentions its occurrence in the LOWER GREEN SAND of Hythe, Kent.

Foreign Distribution.—On the Continent it occurs in the chalk marl of France and Germany. Hillsconglomerat of Essen (Müller).

EXPLANATION OF THE PLATE.

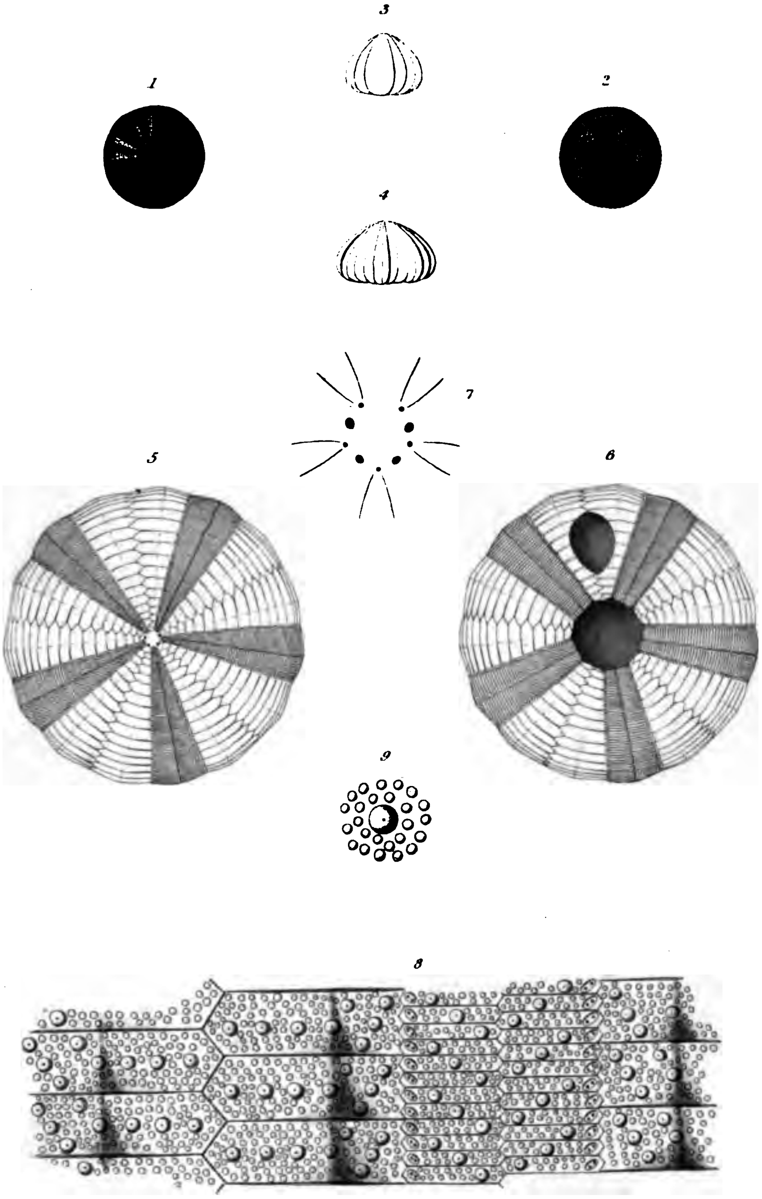
Figs. 1 and 2. Upper and under views of a green-sand specimen. Fig. 3. Profile of a conical green-sand specimen allied to var. β. Fig. 4. Sub-depressed variety. Figs. 5, 6. Magnified representations of the dorsal and ventral surfaces, showing the arrangements of the plates. Fig. 7. Arrangement of the ovarian and ocular pores on the summit. Fig. 8. Ambulacral and interambulacral plates, with their tubercles, granules, and pores. Fig. 9. Primary tubercle surrounded by granules.

E. FORBES.

April, 1849.

Geological Survey of the United Kingdom.

GALERITES
(Cretaceous)



GALERITES (DISCOIDEA) SUBUCULUS . *Leske.*

BRITISH FOSSILS.

Decade I. Plate VIII.

GALERITES (DISCOIDEA) CYLINDRICUS.

[Genus GALERITES. Lamarck. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cassidulidæ.) Body more or less hemispherical, always tumid; ambulacra simple, continuous, radiant; mouth central, inferior; anus inferior, or submarginal; tubercles perforate.]

[Sub-genus *Discoidea*. Body hemispheric, circular, flat-based; tubercles in regular series; inside strengthened by strong ribs.]

Synonyms. *Galerites cylindricus*, Lamarck (in 2nd Ed., iii., p. 311). *Conulus Hawkinsii*, Mantell, Geol. Trans., New Ser., vol. iii., part 1, p. 208. *Galerites Hawkinsii*, Desmoulins, Tab. Syn., p. 254. *Galerites canaliculatus*, Goldfuss, p. 128, pl. 41, f. 1. *Scutella depressa* and *S. hemisphærica*, Woodward, Geol. Norfolk, p. 52, t. 5, f. 4 and 5. *Discoidea cylindrica*, Agassiz, Echin. foss. Suiss., part 1, p. 92, t. 6, f. 13. 15. Desor, Monog. Galerites, p. 58, t. 8, f. 8–16. Agassiz and Desor, Cat. Rais. des Echin., Ann. Sc. Nat., 3rd ser., vol. vii., p. 147. *Galerites* (*Discoidea*) *cylindrica*, Rœmer, Nord-Deutsch. Kreide Geb., p. 31.

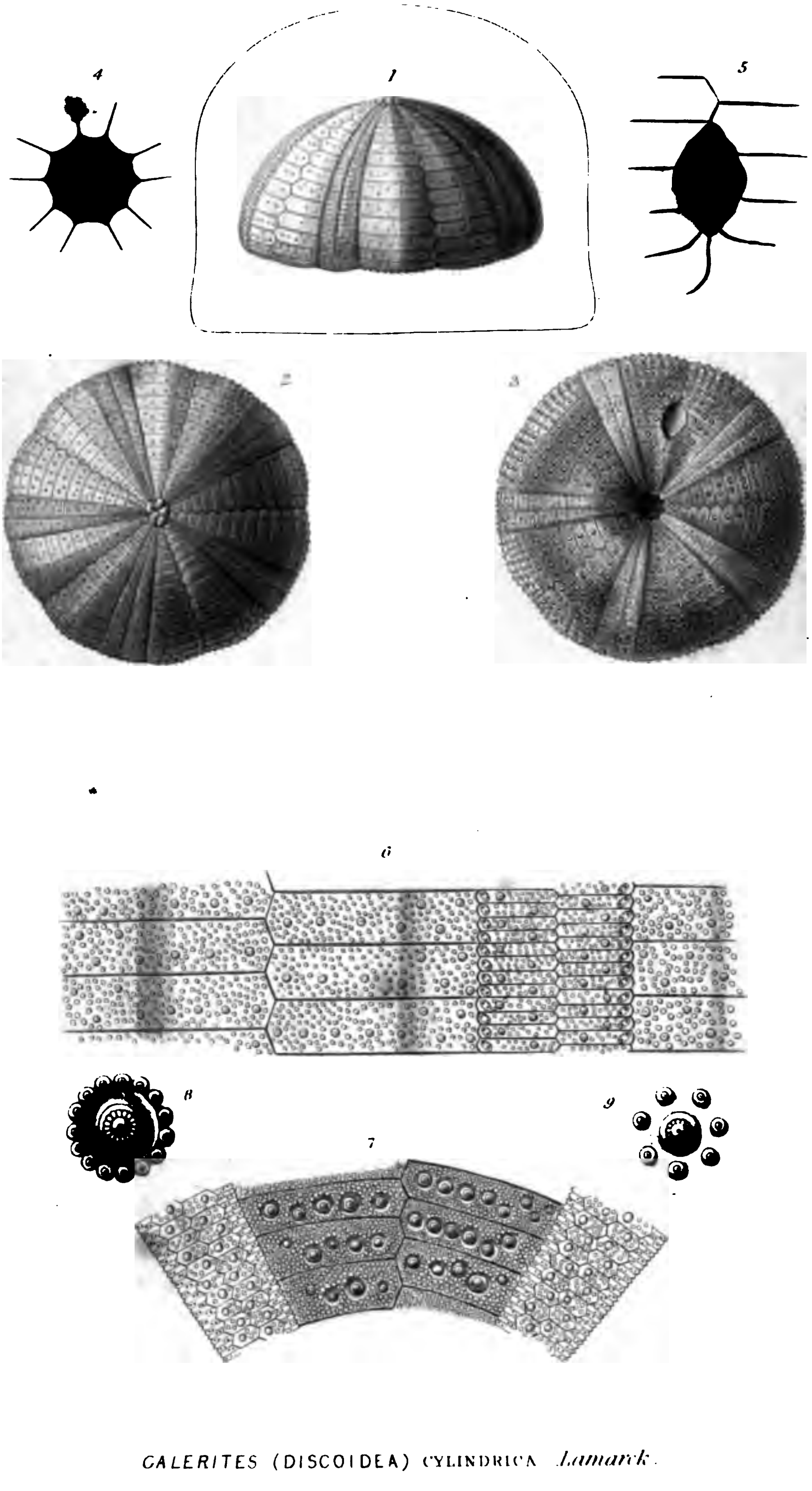
Diagnosis. *G.* (*Discoidea*) *inflata, magna, hæmisphærica seu* (*adulta*), *subcylindrica; ventre plano, ano parvo; areis ambulacralibus tertiam partem arearum interambulacralium æquantibus; assulis ambulacralibus* 5 *ad assulam interambulacralem appositis.*

Desor, in his "Monograph of the Galerites," and Bronn, in his "Index Palæontologicus," refer to this beautiful fossil the figures given by Leske of his *Echinites quaterfasciatus* and *Echinites sexiesfasciatus* (Leske ap. Klein, t. 47, f. 3-5, and 50, f. 1 and 2, copied in the "Enc. Meth." *Echinus quadrifasciatus* and *Echinus sexfasciatus*, Gmelin, 3183 made two species of *Galerites* by Lamarck), considering them as monstrous varieties; but a careful inspection of the figures of Leske, representing two casts, is sufficient to show that they are the nuclei of species of the subgenus *Galerites*, and not of the subgenus *Discoidea*. Had they represented casts of monstrosities of *G. cylindricus*, they would have exhibited the regularly arranged furrows caused by the impressions of the internal ribs. The history of the species dates, therefore, from its definition as such by Lamarck. Desmoulins and Dujardins have confounded it with tertiary urchins, and added synonyms to the Lamarckian name which do not belong to it. The best

DECADE I. Pl. 8.

Geological Survey of the United Kingdom.

GALERITES
(Cretaceous)



CALERITES (DISCOIDEA) CYLINDRICA *Lamarck*.

Allied British Species.

In the collection of Mr. Tennant there is a very beautiful, though imperfect, specimen of a *Discoidea*, nearly allied to, but quite distinct from *cylindrica;* it was found in the upper green sand of Somerset. It measures a little more than an inch in diameter, by nearly eight-twelfths of an inch in height; is hemispheric, with a tendency to become subcylindrical, and has plates horizontally proportioned and ornamented as in the *cylindrica*, but differing materially in their relative number; there being six (instead of four) ambulacrals, and, consequently, as many pairs of pores, to each interambulacral. The anus, moreover, is much nearer the margin, and larger than in the allied species.

The *Discoidea favrina* of Desor (Monog. Galerites, p. 62, pl. 7, f. 12–14, called *rotula* on the plate), from green sand near Rouen, seems to be its near ally, if not identical; though it also resembles considerably the same author's *D. conica* (t. 7, f. 17–22). Unfortunately neither figures nor descriptions indicate sufficiently the distinctive character of the relative numbers of pairs of pores and interambulacral plates. The original *Nucleolites* or *Galerites rotula* of Alexander Brongniart (*see* Cuvier, Ossemens fossiles, vol. ii. p. 614, plate IX., fig. 13), appears, judging from the figure, to be only a rather large specimen of *Galerites* (*Discoidea*) *subuculus*, and is quoted as such by M. Desor, in his synonymy of that species. As such it is quite distinct from the *Discoidea rotula* of Agassiz, in the "Echinodermes fossiles de la Suisse" (1st part, p. 90, t. 6, f. 10–12); but, nevertheless, the same figure of Brongniart is again cited by M. Desor, as a representation of *Discoidea rotula*, at page 61 of his "Monograph of Galerites." Dr. E. Sismonda, in his "Memoir on the Fossil Echini of Nice" (1843), enumerates *Discoidea rotula*, from the green sand near Nice, and cites Alexander Brongniart's figure, as well as those given by Agassiz in his "Descriptions of the Fossil Echini of Switzerland." Unfortunately no figure is given of the Italian species, nor are the relations of the ambulacral, as compared with the interambulacral plates mentioned in his description; but for the comparison he makes of it to the *Discoidea cylindrica*, it is not improbable that our fossil may prove identical specifically with that from Nice. In Mr. Morris's "Catalogue of British Fossils," *Discoidea rotula* is enumerated as a British fossil from the lower chalk of Maidstone and Dover, with a reference to the figures of Brongniart and Agassiz, cited above. This mention of *D. rotula* has escaped Mr. M^{c}Coy, who again enumerates a fossil under that name, referring to Agassiz alone as an authority, in his list of Mesozoic Radiata not included in Morris's catalogue, and preserved in the geological collection of the University of Cambridge (Annals of Nat. Hist., 2nd ser., vol. ii., p. 420): the specimen he cites is from the upper chalk of Norwich.

I think it not improbable that in the end we shall have to adopt the specific appellation *Favrina* for the green sand species; and that the chalk specimens alluded to will prove varieties of *cylindrica;* but a comparison of the types themselves only can settle the matter.

E. Forbes.

April, 1849.

BRITISH FOSSILS.

DECADE I. PLATE IX.

NUCLEOLITES CLUNICULARIS.

[Genus NUCLEOLITES. LAMARCK (sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Clypeasteridæ.) Body oval or cordate, more or less tumid, sometimes much depressed; ambulacra dorsally petaloid; anus supra-marginal; mouth sub-central.]

[Sub-genus *Nucleolites*. Anus superior, in a furrow; mouth not surrounded by tubercles.]

SYNONYMS. *Clypeus clunicularis*, PHILLIPS, Geol. York, part 1, p. 115. *Nucleolites clunicularis*, BRONN, Lethæa Geognost., p. 282.

DIAGNOSIS. *N. ambitu suborbiculari, subquadrato, antice rotundato, postice bilobato; dorso convexo, apice subcentrali, vertice apicali, postice declivente; ambulacris anguste lanceolatis; sulco anali profundo, lanceolato, apiculato, ad apicem angustato, lobis posterioribus vix tumidis; ventre concavo.*

VAR. α. *Major, subdepressa, lata, lateribus tumidiusculis.*—*Spatangus depressus*, LESKE, ap. Klein, p. 238, t. 51, f. 1, 2 (copied in Enc. Meth., pl. 157, f. 5, 6). *Nucleolites scutata*, LAMARCK, An. s. Vert. 3, p. 36. DEFRANCE, Dict. Sc. Nat., vol. xxxv., p. 213. *N. clunicularis*, b. BRONN. Leth., p. 283. *N. scutatus*, AGASSIZ, Echin. Suiss. p. 45, pl. 7, f. 19–21.

VAR. β. *Minor et media, convexa, lateribus tumidiusculis.*—*Nucleolites gracilis*, AGASSIZ, Echin. Suiss. p. 44, pl. 7, f. 10–12?

VAR. γ. *Media, pyramidata, lateribus planiusculis.*—*N. Sowerbii*, DEFRANCE, Dict. Sc. Nat., vol. xxxv., p. 213. *N. pyramidatus*, M'COY, (confirmat. in lit.), Ann. Nat. Hist., 2nd ser., vol. ii., p 416, Dec. 1848. [Variety figured in our plate.]

The name *clunicularis*, as applied to a fossil sea-urchin, has its origin with Llhwyd, who, in his "Lithophylacii Britannici Ichnographia" (1699), describes "Echinites clunicularis. Echinites e lapide selenite, quinis radiis e duplice serie transversarum lineolarum conflatis," and refers to certain figures in the works of Lister and Plot. The figure in Plot ("History of Oxfordshire," tab. 11, f. 12) represents a body which is possibly *Nucleolites clunicularis* of Phillips, but so badly, that no anal furrow, or anus, is delineated. This figure is referred to by Lister, in his book "De Lapidibus Turbinatis (1678), cap. 11, titulus xxvi.," with a query whether it be identical with his own figure, t. 7, p. 26, which represents a fossil from Newton Grange, distinctly a Nucleolite, and in all probability var. β of the species we are describing. To this figure the name *Clypeus lobatus* is applied by Dr. Fleming, in his "History of British Animals" (1828), p. 479, while the name *Clypeus clunicularis* is given to the nucleolite figured by William Smith, in his plate of the Coral Rag fossils (Strata Identified, 1817), and characterized in his "Stratigraphical Table of Echini," where it is marked as ranging through upper oolite, "the clay over it," cornbrash, and coral rag. Smith gives no name further than noting it as species No. 2 of *Clypeus*, and, judging from his description, probably meant to include both the *clunicularis* and *dimidiatus* of Phillips, whilst his figure seems to represent the latter.[*] Fleming, in making two species (*Clypeus lobatus* and *Clypeus clunicularis*), overlooks the fact that the figure of Lister, on which he founds the former, is the very representation quoted by Llhwyd as representing *Echinites clunicularis*. We next come to John Phillips, who, in his "Geology of Yorkshire," part 1 (1835), figures in his plate of fossils of the Cornbrash, under the name of "*Clypeus clunicularis*, Llhwyd," the nucleolite to which he would preserve the name. Although the figure is far too slight, and no profile is given, there can be no question as to what it is meant for, since, in the first place, the peculiar form of the anal furrow is correctly indicated; and, in the second, a new species of "*Clypeus*," from the coralline oolite, is figured under the name *C. dimidiatus*, representing the only other British form to which the figures of Plot and Lister might be applied. In the text of his "Lethæa Geognostica" (1835-37), p. 282, Bronn distinguishes between the *Nucleolites clunicularis* and the *N. scutatus* of Goldfuss (t. 43, p. 6), holding the latter, in which opinion I agree, identical with the *dimidiatus* of Phillips. At the same time he makes the *Spatangus depressus* of Leske's edition of Klein (*Nucleolites scutata* of Lamarck) a variety of *clunicularis*. In the "Catalogue Raisonné des Echinides" of Agassiz and Desor (1847) the second fossil species of *Nucleolites* enumerated is *clunicularis*, Phillips being the authority taken. For the reason, therefore, that the original name, *clunicularis*, as applied by Llhwyd, in all probability included the form before us, whilst the stricter application of it by Phillips is followed by Bronn and Agassiz, the reference of it by

[*] Since the above passage was written I have been enabled to examine Smith's original specimens, now lying among undisplayed treasures in the British Museum. They are ten in number; eight preserve the original lettering. "B. 1. *a*. Bruham," is a sub-depressed specimen of var. β of *clunicularis*; "B. 1. *a*. Mayhill," is *dimidiatus*; "B. 1. *b*." locality washed off, is *clunicularis*, var. α; "B. 1. *c*. Wraxhall," is *clunicularis*, var. β; "B. 1. *d*.?" label washed off, but probably the Seaford specimen mentioned in the Stratigraphical System, p. 69, is a *dimidiatus*; "B. 1. *e*.," no label, probably the Trowle specimen, is *clunicularis*, var. γ; "B. 1. *f*.," no label, probably the specimen from "South-west of Tellisford," is an intermediate form between α and β of *clunicularis*; "B. 2." is the same form, and a second specimen marked "B. 2." is a small *clunicularis*, α.

Fleming to Smith's figure being a mistake, we retain it for the fossil now figured, and the varieties here associated with it.

As, however, the name has been used with different degrees of restriction, it is necessary further to inquire into the grounds of its limitation by different naturalists, and also how far varieties more or less marked have been separated with specific appellations from the normal form. And this leads us to inquire what may be the *Nucleolites scutata* of Lamarck (Animaux sans Vert., 3, p. 36). That author cites, first, the "Echinobrissus" of Breyn.* Next the *Spatangus depressus* of Leske's edition of Klein (1778), t. 5, f. 1-2, copied in pl. 157, f. 5-6, of the "Encyclopédie Méthodique;" and he quotes a second variety, with a higher back, also from a figure of Breynius. These figures agree, as well as old and nearly worthless representations can agree, with our variety *α major;* and I assent to the proceeding of Bronn, who considers it a variety of *clunicularis*, of the normal form of which however he curiously enough quotes the figure in Breynius, first referred to by Lamarck as a representation of his *scutatus.* In the second edition of Lamarck, vol. iii. (1840), Dujardin brings in a new set of synonyms, including *Clypeus lobatus*, Fleming, and *Nucleolites clunicularis*, Bronn. They are brought together, as is too frequently the practice among authors who make a great display of synonyms, without regard to their origin, whether original and critical, or blindly copied. The diagnosis originally given by Lamarck is scarcely sufficiently distinct to warrant our using *scutata* as a specific appellation in preference to *clunicularis;* however, he gives no locality for his fossil. The name *Spatangus depressus* of Leske is adopted as *Echinites depressus* by Schlotheim (Petrefactenkunde, 1820), and he gives Essex as a locality for his specimen. This was probably a mistake, and as there may be doubts about Leske's species, that name had better also be dropped. In the article *Nucleolites*, "Dict. des Sc. Nat.," vol. xxxv. p. 213 (1825), Blainville quotes the species *Nucleolites scutata* after Lamarck, and also mentions that the locality is unknown. Alongside of it he gives *Nucleolites Sowerbyi*, Defrance, with a few words of description stating that the species is very concave beneath, and that the anus is placed very near the summit. He states that it occurs near Caen, in "la couche a polypiers," and near Sandwich, in England—an evident mistake. This possibly may be intended for our typical *clunicularis,* but to such a description, unaccompanied by a figure, we can give no authority. In F. A. Römer's "Versteinerungen des Nord-Deutschen Oolithen Gebirges" (1836), a Nucleolite is figured (pl. 1, f. 19,) and described under the name of

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* Breyn (Schediasma de Echinis, 1732) has two species of his "Echinobrissus," *E. planior,* the figure of which (t. vi. f. 1, 2) appears to be our var. *α*; and *E. elatior,* which is in all probability a bad representation of our var. *γ*.

planatus. This Bronn identifies with *scutata*, Lamarck; but, though evidently nearly allied, the depression is so great, and the anal furrow so peculiarly shaped, that we cannot admit its identity. Bronn has also referred with a query Goldfuss's figure of *Nucleolites cordatus* (pl. 43, f. 9,) to it. That figure would serve as an excellent representation of some of the varieties of *clunicularis*, but as it is a highly magnified representation of a cretaceous fossil, it is probably distinct. The most important works on fossil urchins remain to be cited, viz., those of Agassiz. The first part of this eminent naturalist's work on the fossil Echinodermata of Switzerland (1839) includes a monograph of the Swiss *Nucleolites* (using the term in a very restricted sense), eight in number, five of which are oolitic. Of these the first (*Nucleolites latiporus*) appears to be a variety, more conical than usual, of *N. dimidiatus*, Phillips. I have seen such a form in the collection of Mr. Tennant. The second (*Nucleolites micraulus*) comes exceedingly near the same species. The third (*Nucleolites gracilis*) is to my eye one of our commonest forms of *N. clunicularis. Nucleolites scutata*, Lamarck, placed fourth (distinguished from *N. scutatus*, Goldfuss, which is unquestionably *dimidiatus*), is our var. *α* in the form when passing into *β*. The fifth (*Nucleolites major*) is, judging from the figure, a slightly more elongated and large variety of the same. The figures of all these are so very excellent, that I do not hesitate in giving these opinions, especially as the descriptions do not seem to contradict my conclusions. The later work of Agassiz and Desor, "Catalogue Raisonné des Echinides" (1847), is not so satisfactory. The first fossil *Nucleolites* there given is *scutatus*, Lamarck, with reference to the figure in the "Echinodermes Suisses." The second is "*N. clunicularis*," Phillips, the geology of Yorkshire being the first citation; its synonyms are "*Nucleolites Goldfussii*," Desmoulins, and "*Nucleolites Sowerbyi*," Defrance. The latter reference we have already seen to be next to worthless; the former name is stated by M. Agassiz himself to have been given by Desmoulins to the *N. scutatus* of Goldfuss ("Ech. Suisses," pl. 1, p. 45). Yet in this catalogue the name of Goldfuss is quoted as a synonym of *N. micraulus*, Agassiz, (on which I have already remarked; but it appears to be *dimidiatus*, Phillips,) whilst *dimidiatus* is enumerated as a distinct species, identical with *Nucleolites paraplesius* of Agassiz's "Catalogue Systématique." Then comes *N. latiporus*, Agassiz, with the note that it is probably a variety of *clunicularis*; whereas, in the "Echin. Suiss.," p. 43, it is compared with *Goldfussii*, and a new species, *N. Terquemi*, said to be near *clunicularis* also, whilst *gracilis* is retained as distinct. Further on M. Desor has made a new species, "*N. Thurmanni*," for a cornbrash *Nucleolites*, "assez voisin du *N. latiporus*," which we had been already told was itself "peut-être une variété du *N. clunicularis*." We thus become involved in a labyrinth of names, several of which are unaccompanied by either descriptions or figures, a state of things more likely to retard than to advance our palæontological studies. Lastly, in the "Annals of Natural History," for December, 1848, three new British oolitic *Nucleolites* are described by Mr. M'Coy, under the names *planulatus*, *pyramidalis*, and *æqualis*, all of which I cannot help surmising will prove, on closer examination, but varieties of *clunicularis*. The second, *N. pyramidalis*, from the cornbrash of Weymouth, has been identified by Mr. M'Coy with the figure on our plate, he having kindly replied to that effect to my inquiries on the subject. In his Paper he remarks, "This resembles the *N. clunicularis* (Smith, sp. *Clypeus lobatus*, Flem.) in the long, deep, narrow posterior sulcus, extending quite from the vertex, but is wider and more quadrate, the base having exactly the form of the *N. scutatus*, Lamarck; from the latter it differs in the strong sulcus uniting the pores, as in most of the genus, and from both species it is distinguished by its pointed elevated apex, and the straight declivity of the posterior side." On this passage I would remark that, in the first place, the name *clunicularis* is not given by Smith, whose figure (without a name) probably represents *dimidiatus;* that *Clypeus lobatus*, Fleming, was a name given by that author to a species he considered distinct from his *clunicularis*, "Smith," as I have already shown; that "a strong sulcus" unites the pores quite as much in the var. *scutatus* as in var. *pyramidalis;* and that the degree of elevation of the apex and declivity of the posterior side varies not only in every variety, but in almost every specimen, among the many I have examined,* of all the varieties of this variable species.

Description.—Outline suborbicular, with a tendency to quadrate, broadening out slightly, and more or less bilobed posteriorly, rounded anteriorly. Back more or less elevated, varying from subdepressed (var. α) to subconical (var. γ), but exhibiting all intermediate degrees of convexity. The true apex is invariably the highest point, from which the sides decline with greater or less steepness, and anteriorly with more or less straightness. The apex is always excentric, inclining towards the anterior extremity. The portion of the back in front of the apex is about one-sixth shorter than that behind it. The anal furrow reaches quite to the apex, in some specimens slightly indenting it. It is always of a lanceolate-acuminate form; lanceolate to the upper part, the anus then narrowing into a prolonged and shallower, but still strongly marked groove. The anus is very deep sided, and the bounding walls of the groove diverge slightly downwards. The lower part of the groove, behind the anus, is very much depressed and well defined. The ambulacra are petaloid with subparallel sides, the spaces between the rows of pores forming each ambulacrum varying slightly in width in different specimens; those of the two posterior ambulacra widest. The upper part of the latter run close in contact and partly over the edge of the superior or narrow portion of the anal groove. The furrow uniting the pairs of pores varies in depth in different examples. The number of conspicuous pores in each row dorsally is from 36 to 40. The spaces separating the grooves linking the pairs of pores are minutely granulated. The whole surface of the dorsal, lateral, and inferior ambulacral and interambulacral plates is covered with thickly-set minute spiniferous tubercles, lodged in moniliform depressions, the interspaces minutely granulated. The ovarian plates are well covered with similar granules, no tubercles. The ovarian pores are conspicuous, except the posterior one, which is obsolete. Very distinct holes for the ocelli are seen at the summits of the ambulacral avenues. The ventral surface is more or less concave, most so in the pyramidal varieties. The ambulacra radiate in depressed furrows from the mouth, becoming shallower towards the margin. The mouth is more eccentric, and nearer to the anterior margin than the apex. The tubercles on the ventral surface are rather more scattered than on the dorsal.

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* Through the kind co-operation of Mr. Woodward, the *Nucleolites* of the British Museum were laid out for my inspection.

Comparative Dimensions of average Specimens of each of the three varieties (all of which, however, insensibly pass into each other), in inches and twelfths.

——	α	β	γ
Length	$1\frac{4}{12}$	$0\frac{11}{12}$	$1\frac{1}{12}$
Breadth	$1\frac{2}{12}$	$0\frac{11}{12}$	$1\frac{4}{12}$
Height	$0\frac{8}{12}$	$0\frac{6}{12}$	$0\frac{8}{12}$
Apex to anterior margin	$0\frac{8}{12}$	$0\frac{6}{12}$	$0\frac{7}{12}$
Mouth to anterior margin	$0\frac{5}{12}$	$0\frac{4}{12}$	$0\frac{5}{12}$
Length of anal furrow	$0\frac{8}{12}$	$0\frac{7}{12}$	$0\frac{9}{12}$
Breadth of anal furrow at anus	$0\frac{2\frac{1}{2}}{12}$	$0\frac{2}{12}$	$0\frac{2}{12}$

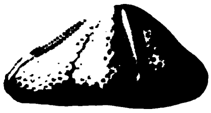
British Localities and Geological Range.—INFERIOR OOLITE, Stroud (B. M.). GREAT OOLITE, Minchinhampton (B.M.). Cirencester (S. P. Woodward). CORNBRASH, Yorkshire (Phillips). Abundant in cornbrash of Dorset (Bristow, Gapper). Chippenham, small gray variety (S. P. Woodward). Northampton (B. M.).

Foreign Distribution.—(Extracted from the catalogue of Agassiz and Desor.) "Oxford. d'Alencon, Courgains (Sarthe), Calc. a Polypiers de Ranville, Coulie.—var. minor. Forest Marble de Chateleensoir." Form *latiporus*, "Cornbrash de Metingen, Maiche." Form *gracilis*, "Ool. Ferrug. de Durrenast (Jura Soleurois)."

Geological Survey of the United Kingdom.

NUCLEOLITES
(Oolitic.)

3



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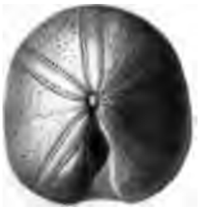

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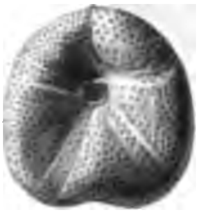

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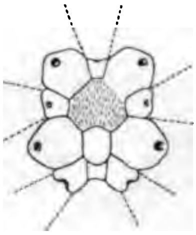

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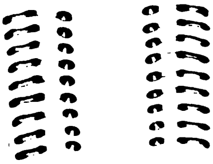

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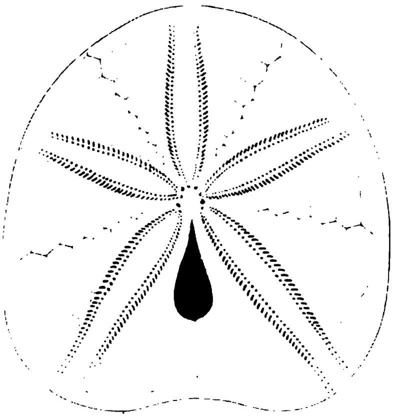


NUCLEOLITES CLUNICULARIS . . *Phillips.*

[illegible] [illegible]

Description of the Plate.

Fig. 1, var. γ, dorsal view. Fig. 2, ventral surface. Fig. 3, profile. Fig. 4, diagram of the dorsal structure. Fig. 5, apical disk of ovarian and ocular plates. Fig. 6, portion of surface of a plate magnified. Fig. 7, arrangement of the pores in the ambulacral avenues.

Note on British *Nucleolites* allied to *N. clunicularis.*

Under the generic appellation *Nucleolites* I include all the members of the family *Cassidulidæ* (Agassiz) with petaloid ambulacra and a supra-marginal anus, and under the subgenus *Nucleolites* those members of the genus so called, in which the anus is placed high up within a deep sulcus. To the orbicular species of this division the generic term *Clypeus* (Klein) is restricted in the arrangement of Agassiz, who styles those only *Nucleolites* in which the shape is more or less angularly subquadrate. He further distinguishes between the two sections by the presence of tubercles or prominences around the mouth in the former, and their absence in the latter, a distinction which does not hold good, since in *Nucleolites lacunosus* the oral prominences are more strongly marked than in *Clypeus Hugii.* There is, moreover, a gradual progression of form from the almost completely orbicular outline of *Clypeus sinuatus* to the ovate contour of *Nucleolites lacunosus.*

Though the name *Clypeus* was used by Klein before that of *Nucleolites*, the latter is preferred because proposed as a definite generic appellation by Lamarck.

Our British Nucleolites are all either oolitic or cretaceous. In the species of the older secondary rocks we find a structure of the ambulacral pores which distinguishes them easily on close examination, however nearly they may resemble at first glance, from those of the upper secondaries. The former have the external series of pairs of pores in each ambulacrum more or less widened and marked by conspicuous connecting furrows; the latter have the pairs of pores in the outer series closely set together, and the furrows consequently indistinct. The widening of the avenues by poriferous sulci is most conspicuously exhibited in *Nucleolites sinuatus*, and in this species and its allies the pores of the ambulacra near the mouth have a tendency to fall into ranks of several pairs.

The British *Nucleolites* known to me are the following;—

A. Species of the Oolitic Type.

1. *Nucleolites clunicularis* (including *scutatus* or *depressus*, and *pyramidatus*), as defined in the preceding account of the species.

2. *Nucleolites dimidiatus* (Sp.), Phillips, Geol. of Yorkshire, vol. i., pl. 3, f. 16. Coralline Oolite.

N. ambitu ovato, antice rotundato, postice bilobato; dorso convexo, apice centrali, vertice subcentrali, postice tumido; ambulacris anguste lanceolatis; sulco anali profundo, ovato, obtuso, superne abbreviato, lobis posterioribus tumidis; ventre plus minusve concavo.

This species rarely exceeds an inch in length, and varies greatly in the convexity of its upper surface. The ovate anal sulcus, reaching about two-thirds of the distance between the posterior margin and the true summit, conspicuously distinguishes it from *clunicularis*, with which it was confounded before being distinguished by Phillips.

It occurs in both coral rag and cornbrash, but especially in the former.

3. *Nucleolites orbicularis* (Sp.), Phillips, Geol. of Yorkshire, vol. i., pl. 7, fig. 3.

N. ambitu orbiculari, lateribus tumidis, dorso convexo, apice vertice-que centrali, ambulacris lanceolatis, ad apices distantibus; sulco anali oblongo, obtuso, ad verticem approximato, lobis posterioribus obsoletis; ventre concavo, ore subcentrali.

Usual diameter about an inch and a quarter. Cornbrash of Wilts and Yorkshire. Coral rag of Calne. The ocular plates are more apart, and the vertex consequently broader in this than in any other British *Nucleolite*.

4. *Nucleolites Hugii*, Agassiz, Echin. Suiss. vol. i.. p. 35, t. 5. figs. 1-3.

N. ambitu suborbiculari, subsinuato, lateribus decliventibus; dorso convexo apice subexcentrali, supra-anali, vertice excentrico; ambulacris lanceolatis, ad apices approximatis; sulco anali oblongo, obtuso, lato, brevi, ab vertice distante; lobis posterioribus obsoletis; ventre concavo, ore valde excentrico.

About the size of the last. Inferior oolite of Stroud (Mr. J. G. Lowe), communicated by Mr. Woodward.

5. *Nucleolites sinuatus* (Sp.), Leske. Parkinson, Org. Rem., vol. iii., pl. 2, fig. 1. 2. *Galerites patella*, Lamarck (? of Agassiz, Echin. Suisses).

N. ambitu orbiculari, lateribus decliventibus; dorso subdepresso, apice vertice-que vix centrali; ambulacris late lanceolatis, ad apices approximatis; sulco anali lanceolato acuminato, in verticem prolongato, profundo, lateribus abruptis; lobis posterioribus nullis; ventre concavo.

Two inches and a half, or more, in diameter. Cornbrash, great oolite, inferior oolite, and coralline oolite in many places.

In the "Catalogue Raisonné des Echinides," of Agassiz and Desor, there is a *Clypeus rimosus*, "Espèce plate, discoide à ambulacres costules," evidently nearly allied to this species, and said to be from oolitic strata in Gloucestershire; it is in the collection of M. Deluc.

6. *Nucleolites emarginatus* (Sp.), Phillips, Geol. of Yorkshire, vol. i., t. 3. f. 18.

N. ambitu orbiculari, lateribus decliventibus; dorso subdepresso, apice vertice-que vix centrali; ambulacris late lanceolatis, ad apices approximatis, sulco anali brevissimo, obtuso, ab vertice valde distante; lobis posterioribus obsoletis.

As large as the last species. In the coralline oolite of Yorkshire.

Besides the above-named species, there is a small Nucleolite from the great oolite of Harleston, apparently distinct, allied to *clunicularis*. In the British Museum.

In the same collection there is also a small species from the inferior oolite of Stroud, which is probably new. See also Mr. M'Coy's paper in Ann. N. H. 3rd ser. vol. ii, p. 417.

B. Species of the Cretaceous Type.

7. *Nucleolites cordatus*, Goldfuss, Pet. Germ., pl. 43, fig. 9.

N. ambitu ovato-rotundo, antice rotundato postice vix bilobato; dorso convexo, apice vertice-que centrali; ambulacris anguste lanceolatis; sulco anali profundo, late-lanceolato, superne subacuminato, lobis posterioribus tumidiusculis.

Upper green sand of Wiltshire. In Mr. Tennant's collection. The specimen agrees in form, tumidity, and size, with that figured by Goldfuss. It is not so distinctly lobed posteriorly, and the anal furrow is not so narrow or acuminate.

8. *Nucleolites lacunosus*, Goldfuss, Pet. Germ., t. 43, fig. 8.

N. ambitu ovato, antice obtuso, postice subquadrato, subtruncato, lateribus subcompressis; dorso convexo, apice subcentrali seu supra-anali, vertice excentrico; ambulacris lanceolatis, lateribus subrectis; sulco anali profundo, brevi, oblongo, abrupte declivente, lobis posterioribus subdepressis; ventre excavato.

Specimens are usually about half an inch in length. Common in the upper green sand of Warminster (Survey Collections).

9. *Nucleolites Morrisii*, Forbes; *Cassidulus lapis cancri*, Morris, Cat. p. 49 (not of Goldfuss).

N. ambitu oblongo, antice postice-que obtuso, lateribus depressis, dorso depresso, apice subcentrali, vertice centrali; ambulacris linearibus; sulco anali profundo, brevissimo, subtriangulari; lobis posterioribus nullis; ventre excavato.

Large specimens are half an inch in length. Upper green sand of Warminster and Blackdown (Mus. Tennant).

E. Forbes.

April, 1849.

BRITISH FOSSILS.

DECADE I. PLATE X.

NUCLEOLITES (CATOPYGUS) CARINATUS.

[Genus NUCLEOLITES. LAMARCK. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Clypeasteridæ.) Body orbicular, oval, or cordate, more or less tumid, sometimes much depressed; ambulacra dorsally petaloid; anus supra-marginal; mouth sub-central.]

[Sub-genus *Catopygus*. Outline narrowing anteriorly; body truncated posteriorly, with the anus on the superior surface of the truncation. Tubercles around mouth conspicuous.]

SYNONYMS. *Nucleolites carinatus*, GOLDFUSS, Pet. Germ., p. 142, pl. 43, f. 4, *a–c*. *Catopygus carinatus*, AGASSIZ, Cat. Syst., p. 4. AGASSIZ and DESOR, Cat. Rais. des Echin., Ann. Sc. Nat., 3rd ser., vol. vii., p. 157. BRONN, Lethæa Geog., p. 613; Index Paleont., p. 249. MORRIS, Cat., p. 49.

DIAGNOSIS. *N.* (*Catopygus*) ***ambitu ovali seu subrotundo, postice plus minusve dilatato; dorso convexo, prope anum obsolete carinato; apice excentrico, vertice post apicem; ambulacris lineari-lanceolatis; extremitate anali truncata supra anum prominente, subapiculata, ano suboblongo in parte superiori posito; ventre convexiusculo.***

VAR. α. *ovato-rotunda, dorso tumido.*—*Nucleolites carinatus*, GOLDFUSS, Pet. Germ., pl. 43, f. 4, *a–c*.

VAR. β. *ovata, dorso antice declivente.*—*Nucleolites columbarius*, D'ARCHIAC, Mem. Geol. Soc. France, 2nd ser., vol. ii., pl. 13, fig. 3, *a*, *b*, *c*?

VAR. γ. *oblonga.*

VAR. δ. *subglobosa.*

The clear and distinct history of this fossil urchin dates from the excellent figure and description given by Goldfuss in the *Petrefacta Germanica*, where the *Nucleolites columbaria* of Lamarck is cited as a questionable synonym, and the *Echinites pyriformis* of Parkinson referred to without mark of doubt. Parkinson's species (Organic Remains, v. iii. pl. 3, f. 6), however, was from the Maestricht beds, and was rightly identified by him with the *Echinites pyriformis* of Leske (t. 44, f. 7 and 51, f. 5, 6), which circumstance seems to have escaped Goldfuss, who quotes the figures in Leske for his *Nucleolites pyriformis* (Pet. Germ., p. 141, t. 43, f. 7, *a—f*.) A comparison of specimens of the Maestricht fossils with ours has confirmed their distinctness; the anus in the former, as indeed it is represented by both Leske and Parkinson, being much nearer the posterior margin, and the ambulacra much narrower than in *N. carinatus.* The *Nucleolites columbaria* of Lamarck was a species very insufficiently described by that author, who cites no figure, and mentions that it is found as fossil in the environs of Mons. In Count D'Archiac's valuable report on the fossils of the Tourtia, a remarkable cretaceous conglomerate found in Hainault and a part of French Flanders, a detailed and most excellent description is given of the *Nucleolites columbarius* of Lamarck, which is there distinguished from the *Nucleolites carinatus* of Goldfuss, from which it is stated to differ in its general form being more elongated, more depressed, and consequently less globular. Excellent figures are at the same time given, which, however, so closely resemble one of the commonest forms of our English *carinatus*, and certainly one not distinct, that I do not venture to separate the species; nor does the accompanying description contradict their identification. One point only in the figure seems to differ; the upper margin of the anus is not so prominent in the French specimens as in ours. M. Desmoulins is quoted by M. D'Archiac as having identified the species of Goldfuss with that of Lamarck. In the "Catalogue Raisonné des Echinides," the *Catopygus carinatus* is regarded as distinct from the *C. columbarius*, and the figure of D'Archiac is cited for the latter. Under the synonyms of the former, the name "*Nucleolites britanna*, Defrance," is cited, and as a variety, "minor: *Nucleolites ovulum*, Defrance." *Nucleolites* (*Catopygus*) *carinatus* was first enumerated as a British species by Morris in the "Catalogue of British Fossils." In the "Index Palæontologicus," Bronn cites *N. columbaria*, Lamarck, as a questionable synonym of *carinatus*, retaining at the same time *Catopygus columbarius* of Agassiz, for which he refers to D'Archiac's figure and description as a distinct species. In England, so far as I have seen at least, we have only the one species of this section of *Nucleolites*, and that one so variable in its outline that we are naturally led to suppose too many species have been made out of it on the Continent.

Description.—Outline varying from ovate to subrotund, always more or less widening out posteriorly, least so in vars. γ and δ. Back tumid, varying in degree of elevation; in some specimens, especially of var. β, subdepressed and declining anteriorly, in others subconic and much elevated in the centre, when the true apex is almost at the same spot with the highest point; the latter is usually, however, behind the ovarian disk. The apex is always more inclined to the front than to the posterior extremity. The sides, in all the varieties among British examples, are rounded with a very slight degree of compression in all varieties. The posterior extremity is truncated more or less abruptly. A more or less developed obtuse carination runs down the posterior ambulacral space, with a curvature to a culminating point forming the superior margin of the anus, and part of a prominent, and in some specimens apiculated, arch over that aperture. The anus itself is vertically oval; it varies in size in different specimens, but is always small in proportion to the body; it occupies the upper portion of an obsolete and obscure groove, which vanishes as it approaches the posterior margin. The anus is always nearer the posterior margin than the apex. The ambulacra are narrowly lanceolate and faintly petaloid; they preserve the same proportions in all the varieties. They are nearly equidistant from each other at their summits. The number of pairs of pores in each row is nearly equal in all, and varies from 28 to 30 in well-grown specimens. The outer pores in each pair are elongated and oblique, and the two pores are connected by a groove more or less distinct in different examples. The ridges separating the grooves are rounded and smooth. The ambulacral plates between the rows of pores are narrow, small, and very numerous, but become much larger and broader suddenly, as the ambulacra vanish. Each of these broader ambulacral plates has a pair of minute pores, seeming to the eye as single, at its inferior and exterior angle. The interambulacral plates are ample and oblong. Both sets of plates are covered by minute moniliform tubercles, interspersed with still smaller granules, and only to be distinctly seen in exceedingly well-preserved specimens. There are four perforated ovarian plates, and five oculars, with very distinct eye-pores. The two anterior pairs of ovarian pores are placed nearer together than the two posterior ones, in consequence of the anterior ambulacrum, which is narrower than the others, only separating the former, whereas the latter are separated by the summits of the two postero-lateral ambulacra. In consequence, also, of the two antero-lateral ambulacra being rather broader than any of the others, the lateral distance between each pair of ovarian pores is greater than the distance between the frontal pair. The centre of the ovarian disk is occupied by a distinctly marked punctated madreporiform tubercle. The ventral surface is nearly plain, or very slightly convex. The tubercles on it are larger than those of the dorsal. The mouth is eccentric in the direction of the anterior extremity. It is pentagonal, and surrounded by five prominent tubercles, which terminate the inferior interambulacral spaces. These tubercles are curiously granulated in a reticulate fashion. From the mouth radiate ten short petaloid ambulacra, constructed like those of the dorsal surface.

The following table exhibits the comparative dimensions of six specimens, five of which come from the same locality (green sand of Warminster), and one (No. 4) from the junction beds of the green sand and chalk marl at Maiden Bradley, Wiltshire, in which the majority of specimens exhibit the dimensions of No. 3. Of the six, Nos. 1, 2, and 4 may be regarded as belonging to form β, No. 3 to form α, the most common variety, No. 5 to var. γ, and No. 6 to var. δ. These different forms have really scarcely any claim to the rank of varieties, for every degree of intermediate shape is exhibited by specimens collected in the same localities.

—	1	2	3	4	5	6
Length . . .	1	$0\ \frac{11}{12}$	$0\ \frac{10}{12}$	$0\ \frac{9}{12}$	$0\ \frac{8}{12}$	$0\ \frac{7\frac{1}{2}}{12}$
Breadth. . .	$0\ \frac{10}{12}$	$0\ \frac{10}{12}$	$0\ \frac{8}{12}$	$0\ \frac{6}{12}$	$0\ \frac{5\frac{1}{2}}{12}$	$0\ \frac{7\frac{1}{2}}{12}$
Height . . .	$0\ \frac{8}{12}$	$0\ \frac{7}{12}$	$0\ \frac{6}{12}$	$0\ \frac{6}{12}$	$0\ \frac{6}{12}$	$0\ \frac{7}{12}$

British Localities and Geological Range.—UPPER GREEN SAND—Warminster, Wiltshire (Survey Collections); Chute Farm, Wiltshire; Hythe, Kent (Morris). Junction beds of UPPER GREEN SAND and CHALK MARL, Maiden Bradley, Wiltshire (Bristow), (Survey Collections).

Foreign Distribution.—Upper green sand of France and Germany. *C. columbarius*, as defined by D'Archiac, is from the Gault of Mans, Coulaines, and Fouras.

DESCRIPTION OF THE PLATE.

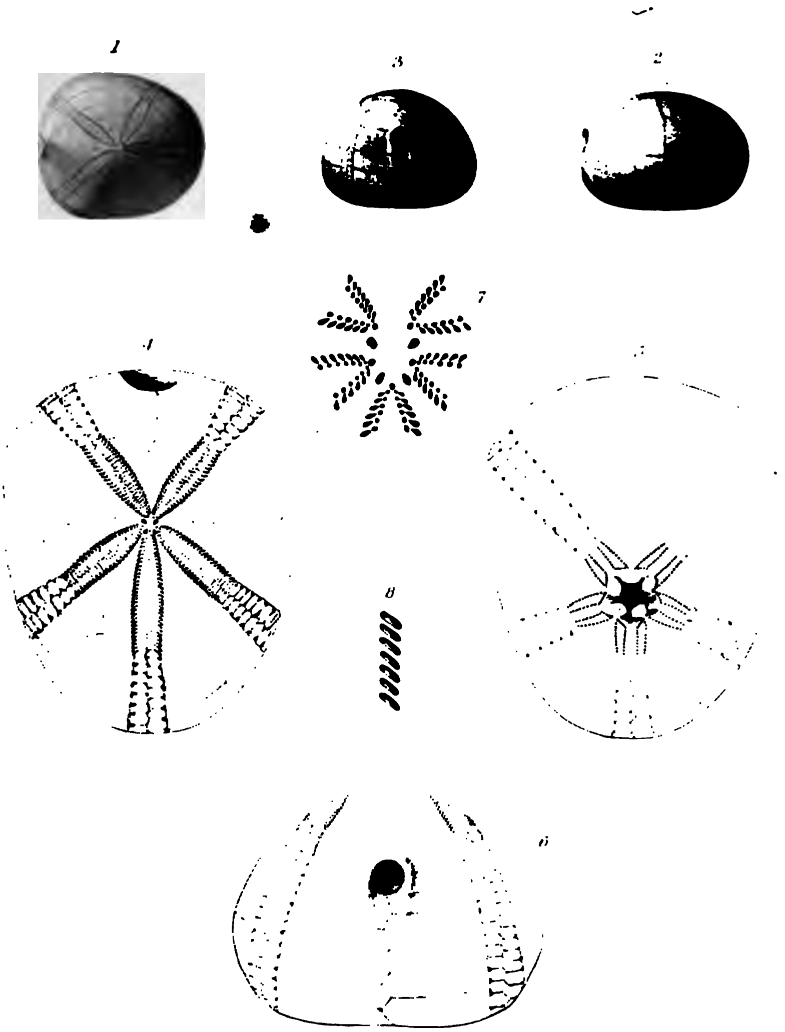
Fig. 1. Specimen of typical form seen from above. Fig. 2. Lateral view. Fig. 3. Posterior view. Fig. 4. Diagram of a specimen of form β, seen from above. Fig. 5. From beneath. Fig. 6. Posterior view. Fig. 7. Diagram of relative positions of ovarian and ocular pores, and summits of the ambulacra. Fig. 8. Arrangement of pores in each ambulacral series.

E. FORBES.

April, 1849.

Geological Survey of the United Kingdom.

NUCLEOLIT
(Cretaceous)



NUCLEOLITES (CATOPYGUS) CARINATUS. *Munster*

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE II.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE:
PUBLISHED BY
LONGMAN, BROWN, GREEN, AND LONGMANS.
1849.

LONDON: PRINTED BY W. CLOWES AND SONS, STAMFORD STREET.

NOTICE.

PALÆONTOLOGICAL researches forming so essential a part of geological investigations, such as those now in progress by the Geological Survey of the United Kingdom, the accompanying plates and descriptions of British Fossils have been prepared as part of the Geological Memoirs. They constitute a needful portion of the publications of the Geological Survey, and are taken from specimens in the public collections, or lent to the Survey by those anxious to advance this branch of the public service. Although numerous drawings had previously been made, and engravings from them considerably advanced, it was not thought expedient to commence their publication until the large collections of the Survey could be well examined, which a want of the needful space has, until the present time, considerably retarded. This impediment to progress is now being removed, and when the collections can be properly displayed in the New Museum of Practical Geology, in Jermyn Street, it is hoped that the public will have an opportunity of gradually obtaining, in a convenient manner and at small cost, a work illustrating some of the more important forms of animal and egetable life there preserved, and which have been entombed during the lapse of geological time in the area occupied by the British islands.

The plan proposed to be followed in the work, of which the two Decades now published form a part, is as follows:—

To figure in elaborate detail, as completely as possible, a selection of fossils, illustrative of the genera and more remarkable species of all

classes of animals and plants the remains of which are contained in British rocks; to select especially such as require an amount of illustration which, to be carried out by private enterprise, would require a large outlay of money, with little prospect of a return, and a long time to accomplish, but which, by means of the staff and appliances necessarily employed on the Geological Survey, can be effected at small cost, and with a rapidity demanded by the publication of the Maps and Memoirs of the Survey; thus, it is hoped, affording an aid to those engaged in the sciences with which this work is connected, that they might not otherwise have possessed, and which may materially promote the progress of individual research.

H. T. De la Beche,
Director-General.

Geological Survey Office,
18*th July,* 1849.

BRITISH FOSSILS.

DECADE THE SECOND

The second Decade of representations of British Fossils contains illustrations of the genera and species of Trilobites.

These remarkable animals, belonging to a group of Crustacea, of which we find no traces in strata formed subsequently to the Palæozoic period, were first observed in British rocks. Nevertheless, the investigation of those species found in our country is as yet far from complete. Our recorded knowledge of them is chiefly contained in the works of Sir Roderick Murchison and of Lieut.-Colonel Portlock. In the "Silurian System," only are figures to be found of our commoner species, and in the "Report on the Geology of Londonderry, Tyrone, and Fermanagh," is the only systematic dissertation on their arrangement, which has yet been published in Britain.

During the progress of the Geological Survey through the Silurian districts of Wales and the bordering counties, much new and important material has been collected towards the elucidation of the structure, affinities, and distribution of Trilobites. The following figures and descriptions consequently contain much that has not been before noticed respecting these animals, and new light will be found thrown on several features of their organization.

The Trilobites selected as subjects for this Decade are species of the genera *Phacops*, *Illænus*, *Asaphus*, *Ogygia*, *Calymene*, and *Ampyx*. Some of them are renowned and characteristic forms, such as *Phacops* (*Dalmannia*) *caudatus*, *Illænus* (*Bumastus*) *Barriensis*, *Asaphus tyrannus*, and *Ogygia Buchii*, which, whilst they furnish excellent typical figures illustrating generic or sub-generic groups, acquire an additional axis of the whole body considerably narrower than the sides. Head finely granular all over, semicircular, without the slightly produced snout, or the long, stout, posterior horns, which are broad at the base, and reach the seventh or eighth thoracic ring. Glabella coarsely tubercular, widened above, more than one-third the width of head, the forehead lobe a transverse rhomb, separated by deep, broad, oblique furrows which nearly meet, from the upper side lobes; three lateral lobes and neck lobe all nearly equal in width, and together equalling the forehead lobe, the first and second lie straight across, and leave but a narrow ridge down the middle: strong axal furrows separate the glabella from the triangular cheeks, of the surface of which the large pyramidal eyes occupy a variable proportion; a lunate depression surrounds their outer edge, and this is sometimes extended over more than half the width of the cheek, sometimes barely half, giving a considerable difference in appearance. The length of the eye, which is sharply curved, is uniformly from the first basal furrow to the middle of the upper one; eyelid with a deep concentric groove; lentiferous surface considerably broader forwards, lenses about 240*, 8 or 10 in a vertical row. In the cast, which represents the crystalline layer behind the lenses, the surface is covered with close-set, circular pits, with narrow distinct borders (Fig. 5); in these hollows the moderately convex lenses are set, and in most specimens we see no cornea over them. In two perfectly preserved eyes from Ledbury (Fig. 4), the cornea is, however, present, and contrary to Professor Burmeister's prediction, is distinctly convex over each lens, the intermediate portions being ornamented with tubercles and granules, so as to leave no doubt of its being the true exterior; it is, too, continuous with the other portions of the preserved shell. The cornea does not rise, as in some other species, into elevated ridges between the lenses, but is flat, or in other specimens (Fig. 6), it sinks down between them. In Fig. 4 a lens or two is seen to be undeveloped and very small, among other perfect ones. The facial suture exactly circumscribes the glabella in front, falls perpendicularly to the eye, and arches outwards and upwards from its lower angle to the outer margin of the head, on the lower face of which it extends along the margin further back than on the upper surface (*see* Fig. 10 *a*). The cheek-pieces are united in one (as in all the genus) across the front, and there is no extra piece inserted between them above the hypostome. The latter (Fig. 3) is parabolic, obtusely pointed, the sides a little waved, and the base of attachment extended; a transverse furrow, within the tip, is connected with a marginal longitudinal one on each side, a pair of lateral strong indentations indicate a second furrow above. Round the head a strong furrow separates the broad margin, stops at the base of the spines, and there nearly meets the equally strong neck furrow, which is arched down at its end. The margin in front more or less produced into an obtuse point. Thorax with the central lobe not separated by any strong furrow from the pleuræ, which, in English specimens, are half as wide again as the axis; the axis is a little fusiform, not broader than the base of the glabella, and either has the rings smooth, tubercled at their outer edges, or with two tubercles on the central prominent part:—all these variations occur on the same thorax. The front pleuræ are flat for the first half, then gently curved down, and a little back, at the obscure fulcrum; they are divided by a moderately strong curved furrow for most of the length, and their edge sharpened anteriorly (the flat surface not crossing the furrow as in true *Phacops*) for bending. The extremities are truncate, and pointed at the hinder corner; posterior pleuræ with the fulcrum at less than half, much more curved back, and strongly pointed, overlapping the upper corners of the tail. Whole surface of thorax finely granular. Tail with the sides meeting below at nearly a right angle, and produced more or less to a sharp point beyond this; axis not much raised, and gently tapering, ending a little abruptly at some distance from the point; it has 11 or 12 ribs, which are accidentally tubercular, like the thorax, sometimes much so; the sides have six, seven, or sometimes eight narrow ribs, strongly arched down at their ends, where they abut suddenly on the smooth margin; each rib is sharply defined behind, and duplicated on its forward edge by a fine rib, running parallel to it along its whole length. The number of the ribs on the tail appears to be as great in the young animal, judging from the beautiful specimen, Fig. 7, from Mr. J. Gray's collection.

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* Buckland, Bridgw. Treat., p. 399, reckons 400. This was probably intended for both eyes.

Variations.—The tail margin varies much in width. In fig. 15 it is very narrow, and the apex little produced. Most of the specimens of var. α, in shale or mud (Fig. 11), have the axis of the head and tail narrower than those in limestone (Fig. 12), and the tail itself broader and more mucronate. From Ludlow we have specimens of this form, with all degrees of attenuation in the mucro. The larger head of var. β (Fig. 14), has the outer margin more expanded than in any limestone one yet seen.

Sex.—Some differences are very observable between individuals of this species, as well as of other species and genera, which are possibly referable to sex. We find the male in insects distinguished by large and prominent eyes, extra length of spines, and narrowness or depression of the body; the latter character is sexual in the crustacea. It is natural to look for some sexual distinctions in animals with such marked forms as trilobites have, but an examination of *Serolis*, the external characters of which, at least, imitate best those of trilobites, does not help out the case. The differences pointed out there by Milne Edwards and Audouin reside in the feet and appendages, not in any general shape, prominence of eyes, or sculpture, and we can, therefore, only surmise from general analogy, that certain individuals with the glabella flattened so as to leave the eyes projecting, the body more depressed, and the spines of the front and sides of the head, or the mucro of the tail more developed, may be males; while greater general convexity, more convex glabella rising nearly as high as the eyes, and a tail not attenuated into the mucro, but simply pointed, may mark the other sex. Fig. 1 we think a female, and in this the eyes seen in front view (Fig. 1 *a*) do not rise much above the glabella, and the body is convex, the tail simply pointed; but in others the glabella is depressed, especially behind, and the front produced. In Fig. 9, supposed to be a male, the produced angular front is shown. Fig. 8 shows the great length the spines of the head sometimes assume.

If *P. longicaudatus*, our var. β, be identical with this species, and it differs in nothing except the greater development of the processes, the probability of this difference being sexual is confirmed, for there occur in the same slabs individuals exactly alike, some with long spines to head and tail, and others without them.

Affinities.—But one European species is sufficiently like ours to render a close comparison necessary. We refer to the *Asaphus mucronatus* (Brongn.), which Professor Burmeister identifies with our var. β; however, he had not seen specimens, and we have them before us. The head of that is regularly convex, the axal and glabellar furrows not deep, the eyes placed further forwards, the margin narrow. The tail is like, but the ribs do not imbricate posteriorly, and the intermediate furrow divides them more equally. The mucro, too, is recurved, as in *P. proevus*, with which, without being identical, it is closely allied. *Asaph. pleuroptyx* (Green, cast 18), has 11 or 12 lateral ribs to the tail, extending below the very narrow axis; but with *P. limulurus* (Green, cast 16), from the Niagara shale, there are so many points of resemblance, that we can hardly persuade ourselves they are distinct. Specimens in the cabinets of Sir C. Lyell and Dr. Bigsby show that the form is more elongate, the pleuræ shorter, the glabella contracted at the base, and the eyes perhaps smaller; the tail narrow, its lateral ribs faint and but little arched, while the extremity of the axis is more prominent. The head wants the strong marginal furrow, and the posterior spines extend but a little way down (to the fifth rib, Hall). While avoiding the risk of a doubtful synonym, we cannot value these mere proportional characters as specific, and believe that a larger series will unite the above and *P. Wetherilli* (Green, cast 20), to the English species.

History.—When Brongniart made the first scientific attempt to classify trilobites, his genus *Asaphus* confessedly stood as debateable land between *Calymene* and *Ogygia*, but he clearly pointed out that the type of the genus, when restricted, should be *Asaphus cornigerus*, a species possessing smooth eyes and eight joints to the thorax. The characters "Tubercules oculiformes reticulès" were drawn from the present species, and the figures also from Dudley specimens. Dalman followed, without much improving this classification, but Quenstedt, in 1837, clearly separated the group of trilobites with facetted eyes, (meaning thereby with large prominent facets), and Emmerich named it *Phacops*. In the treatise on the "Morphology, Classification, &c., of Trilobites," published 1845, in Leonhard and Bronn's "Neues Jahrbuch," Emmerich pointed out the subdivision *Dalmannia*, making *Ph. caudatus* (Brünn.), its type. Burmeister, however, has thought fit to retain all under *Phacops*, and the characters of one group pass so gradually into those of another, that we prefer following his plan, though in the Memoirs of the Geol. Survey, just published, we have adopted the genus (vol. ii., part 1, page 337.) Sir R. I. Murchison, in 1837, gave figures of the ordinary and the tuberculated forms, and there was quite sufficient to justify him in making the var. *longicaudatus* a species. After observation of many intermediate forms, however, we unite them without much doubt of the propriety of so doing. Green, in 1832, did some service by publishing his casts, and he would have done better had he not permitted them to be carved to make them more plain. Milne Edwards adopted the previously published species in his excellent work on recent crustacea. Professor Burmeister confused the synonyms of this species, by too hastily uniting *P. mucronatus* with our var. β; Dalman had well separated the two in 1826. In uniting, as we have done, the var. β to the typical form, we believe we shall be justified by most naturalists, when the numerous varieties common in every collection are examined with a view to this. The combination of characters is the same in both, and variation in isolated points should always be suspected. The reference of such differences to sex is merely speculative, and will require much observation to confirm.

British Localities and Geological Range.—Distributed throughout the Silurian districts, from the lower LLANDEILO FLAGS TO UPPER LUDLOW ROCK. The shales of Kirkcudbright, Scotland (J. W. S.); rarely in the Coniston limestone, Westmoreland; quoted also by Prof. Sedgwick, from Coldwell, ditto (Geological Journal); this is a mistake, as is also the quotation in the list of fossils, *ib.*, vol. i., p. 20. Upper Silurians of Denbighshire (J.W. S.). Near St. Clairs and Narberth, in Llandeilo flags. Marloes Bay, Pembrokeshire (Phillips). Dynevor Park, and numerous localities south and west of Llandeilo; also Rhiw-rhwych and

Cefn Llwydlo, north of Llandovery (J. W. S.) Everywhere in upper Silurian rocks, Herefordshire and Shropshire (Murchison, "Sil. Syst.") Especially abundant in Dudley limestone and shales. Usk, Monmouthshire; in Ludlow and Wenlock rocks (J.W.S.) Horse-shoe Farm, Tortworth; Huntly-hill, Gloucestershire; Caradoc sandstone; Woolhope limestone and upper Silurians of Woolhope, Abberley, and Malvern districts. (Geol. Surv.) Not yet found in Ireland.

Var. β.—Marloes Bay, and St. Ishmael's, Pembrokeshire (Phillips). Cwmdwr, Brecknockshire (J. W. S.). Brindgwood Chase, in Ludlow rocks; Burrington, in Wenlock shale; near Ludlow, Aymestry, and Nash Scar, Herefordshire ("Sil. Syst.") Usk, Monmouthshire, from Wenlock shale to upper Ludlow rock; Abberley and Malvern (Phillips).

Foreign Distribution.—In Gottland, upper Silurian, rare (Dalman and Hisinger.) Ripley, Ohio (Green;—the localities quoted from Canada are erroneous, Dr. Bigsby's specimens being of quite different species, but one, which is probably the true species, was found by him at Gaspè, Gulf of St. Lawrence).

EXPLANATION OF PLATE I.

Fig. 1. Perfect specimen, in Mr. Tennant's cabinet, probably from Dudley.

Fig. 1 *a*. Front view of head; 1 *b*, side view.

Fig. 2. Same, dissected; *a*, front lobe or forehead; *b*, spira or neck lobe; *c*, cheek or wing; *d*, margin; *e*, axis of body ring; *f*, fulcrum of ditto; *g*, part of the axis of a tuberculated specimen; *h*, intermediate ribs of the tail. (These are the indications of separation between the segments.) The *g* at the tail margin should be omitted.

Fig. 3. Hypostome from Ledbury.

Fig. 4. Magnified view of surface of eye, the cornea tuberculate between the convex portions which cover the lenses. At (*a a*), some small abortive lenses are seen. Ledbury.

Fig. 5. A cast of the interior of the eye, the cornea having been removed, and the lenses fallen out. Vinnal Hill, Ludlow.

Fig. 6. An eye, with very prominent lenses, which are partly visible, where the cornea has been broken away. Ledbury.

Fig. 7. A fine young specimen, with rather prolonged tail. Dudley, Cabinet of Mr. John Gray.

Fig. 8. Specimen, with vastly prolonged head spines. Dudley Museum.

Fig. 9. Head, with produced front (male?) Bodenham, Woolhope.

Fig. 10. Cheeks united across the front, and separated from the rest of the head along the facial suture. The course of the suture beneath (at *a*) is rather different from that of the upper side. Vinnal Hill, Ludlow, a rich locality.

Fig. 11. Tail, with the axis narrow and the point prolonged. Intermediate between *P. caudatus* and the var. *longicaudatus*. Vinnal Hill.

Fig. 12. Tail of ordinary form. From Wenlock limestone of Clincher's Hill, South Malvern.

Fig. 13. Tail of var. *β*, *longicaudatus*. Craig-y-Garcyd, Usk, in Wenlock shale.

Fig. 14. Head of same variety. Burrington, Ludlow.

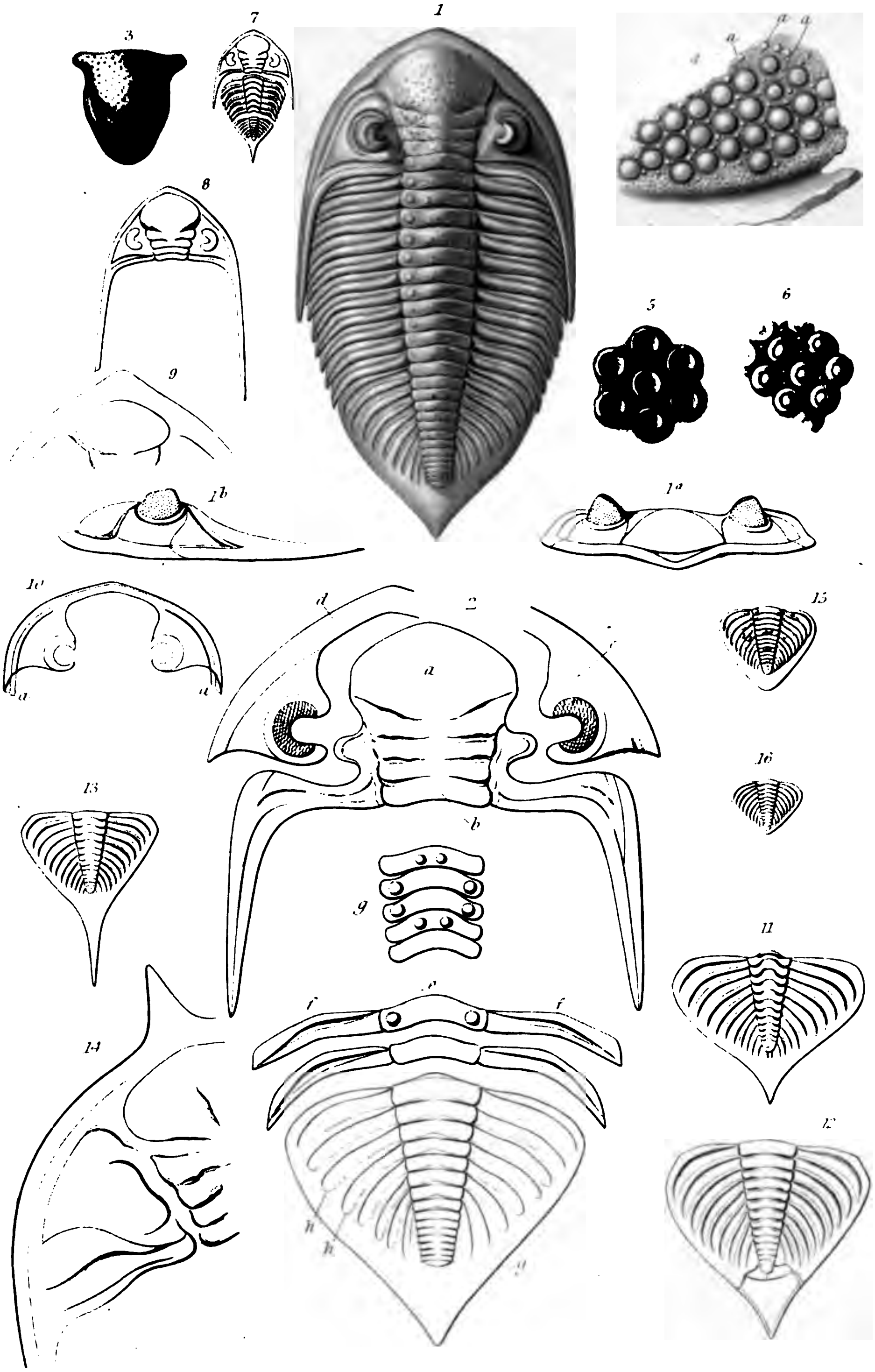
Fig. 15. Tuberculated (diseased?) tail, with very narrow border. Rock Farm, May Hill.

Fig. 16. Accidentally introduced; it belongs to the species next described. Long's Quarry, Tortworth.

DECADE 2 PL. 1

Geological Survey of the United Kingdom.

PHACOPS
(Silurian.)



PHACOPS (DALMANNIA) CAUDATUS — Brünnich.

Other British Species of Phacops, of the Section Dalmannia.

1. *P.* ——— *sp.* [fig. 16 in Pl. I.]

P. lævis, capite quam in P. cauduto, nisi lobis glabellæ tumidioribus;—caudâ triangulari, ferè æquilatera, convexa, apice acuto haud mucronato, axi 13–16 *annulato, costis lateralibus* 10–12, *simplicibus, vix curvatis, ad marginem æqualem angustum abruptè terminatis.*

Length of tail 1½ inches. There are but imperfect heads in the collections of the Geological Society and Geological Survey. The characters of the tail distinguish it from *P. caudatus;* it has much more numerous ribs, which are but little curved, and not duplicate; the margin, too, is equal all round, not expanded or mucronate at the end. Young specimens have not the full number of ribs, and a few of the upper ones are slightly divided. The most prominent analogy is with *P. Hausmanni,* Brongn.; but that is strongly tuberculate, almost spinous, all over. *P. pleuroptyx* (Green), is also like, but has the lateral ribs duplicate. The species of this group so closely resemble each other, that we dare not give a name. Should it prove new, it might be called *P. Weaveri.*

Localities.—Caradoc sandstone of Long's Quarry, Damory Bridge, and Charfield Green, Tortworth, Gloucestershire; (all small); Woodford Green, ditto; (large).

2. *P. obtusicaudatus.*

P. capite quam in P. caudato, sed latiore;—caudâ brevi, lato, subtriangulari, apice angulato, obtuso; axi lato, convexo, 11–12 *annulato, obtuso; costis lateralibus* 9, *duplicatis, rectis, ad marginem angustum æqualem abruptè terminatis.*

We merely note this curious species here; it will be figured and described in Prof. Sedgwick's work on Westmoreland.

Locality.—Coldwell, in flags above the Coniston limestone, Westmoreland.

3. *P. truncato-caudatus,* Portlock, Geol. Rep. Tyrone, &c., pl. 2, f. 1–4, and *Paradoxides? Bucephali* var., pl. 1, f. 8 (hypostome).

P. granulatus, capite antice truncato, oculis maximis subdepressis; pleuris obtusis, fulcro ab axi valde remoto; caudæ axi 18-*annulato, angusto, costis lateralibus* 14–16, *apice emarginato.*

This interesting species, while in the large eyes and strong head spines, numerous joints of the tail, and general depressed form, it is nearly allied to the other *Dalmanniæ,*—yet indicates more than any other the close affinity of this section with *Phacops,* for the facial suture is only just within the margin, the tail rather rounded than produced, the pleuræ have their furrows strong and curved forwards at their obtuse ends, and they are bent down at the distant fulcrum, so as to be much better fitted for rolling up than is usual in *Dalmannia.* For the first half of the thorax they are scarcely at all bent back from the fulcrum; the posterior pleuræ are more in the usual way. The hypostome is very much extended at its base, is pointed, and has two pair of oblique furrows.

Localities.—Lower Silurian. Tyrone, Ireland. Coniston, Westmoreland. Horderly, Shropshire.

VAR. β *affinis. Caudæ axi latiore—Dalmannia affinis,* Salter, in Memoirs of the Geol. Survey, vol. ii., part 1, pl. 5, f. 5.

It is to be feared there are not sufficient grounds for separating this species, founded only on caudal shields. A tolerably perfect tail in Mr. D. Sharpe's collection, and an imperfect one in the Survey Collection, have the axis considerably wider than in Portlock's originals. Specimens, however, in Sir R. I. Murchison's cabinet, show intermediate characters.

Localities.—Lower Silurian. Llandowror, Caermarthenshire. Coniston, Westmoreland.

Phacops is a widely distributed genus or group of trilobites, remarkable for the large facets of the eyes,—the distinct trilobation of head, thorax, and tail, the furrows separating the lobes being strong and deep,—and for possessing eleven joints in the thorax, a number apparently never deviated from. Besides these, in a large part of the genus the convex form of head and tail, the curvature of the segments of the thorax, and the sharpening of their anterior margins, eminently fit the animal for rolling up into a compact ball; for this purpose it is as completely constructed as *Calymene*, while it has the advantage over the latter genus in its large organs of sight. It may be considered as the very type of a Trilobite, possessing all the characteristics of the tribe, with a compact and elegant form. And while the whole group is so bound together by common characters as to render it difficult to separate it into distinct genera, there is a great variation of form among the numerous species. Quenstedt, and after him Emmerich, united them all, and Professor Burmeister has not ventured to dismember the genus. Subgenera, however, have been frequently pointed out, and the groups so formed are very natural. We have—

1st. Convex species, with the pleuræ rounded at the end, and sharpened for rolling; the glabella inflated, and with but one lobe at the base; the facial suture beneath the margin of the head in front; the head angles rounded, the tail of few joints.—*Portlockia*, M^cCoy.

2nd. Moderately convex, with the pleuræ rounded; the glabella not inflated, but with (3) distinct lateral lobes; facial suture marginal in front; head angles rounded, or variously produced, tail few (less than 11) jointed, rounded or pointed.—*Phacops*, Emmerich.

3rd. Characters as given above.—*Dalmannia*, Emmerich.

4th. Flattened; pleuræ pointed, or even mucronate; glabella and facial suture as in Dalmannia; head angles long-spinous; tail many-jointed, the margin produced into spines.—*Cryphæus*, Green; *Pleuracanthus*, Milne Edw.

Odontochile, Corda, is synonymous with *Dalmannia*, and his *Asteropyge* and *Metacanthus* apparently with *Cryphæus*.

The genus is found in all Silurian strata, and existed till the commencement of the Carboniferous system. The distribution of the various subgenera in Britain is as follows:—

Portlockia is found in all the above strata. *P. Stokesii*, Milne Edw., and *P. sublævis*, M^cCoy, Silurian. *P. Latreillii*, Steininger, *P. granulata* and *P. lævis*, Munster, Devonian and lower carboniferous rocks, Devonshire and Cornwall.

Phacops is Silurian. *P. Odini*, Eichwald, *P. Brongniartii*, *P. Dalmannii*, *P. Jamesii*, Portlock, Lower Silurian. *P. Downingiæ*, Murchison, Upper and Lower Silurian.

Dalmannia, Upper and Lower Silurian.

Cryphæus, Green [*C. callitelus*, &c., so named before the definition of Milne Edwards' genus, *Pleuracanthus*], Devonian. A specimen of *C. arachnoides*, Goldfuss, found at Torquay, Devonshire, is in the collection of Mr. D. Sharpe.

J. W. SALTER.

June, 1849.

BRITISH FOSSILS.

DECADE II. PLATE II.

ILLÆNUS DAVISII.

[Genus ILLÆNUS. DALMAN. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Family Trilobitæ.) Head about a quarter of a sphere; eyes smooth, remote; facial suture ending on the posterior margin behind the eye, marginal or submarginal in front; hypostome entire, separated from the facial suture by a transverse rostral shield; thorax segments 9 or 10.]

[Subgenus *Illænus*. Axis of thorax separated from the pleuræ by distinct furrows; fulcrum not close to the axis.]

DIAGNOSIS. *I. capite pygidioque æqualibus; oculis parvis prope sulcos axales, a margine occipitali diametrum et plus distantibus; thorace segmentis* 10, *axi pleuris æquali; fulcro in segmento primo ad axin approximato, in postremo dimidium pleuræ vix attingente.*

SYNONYMS. *I. Bowmanni* [Specimens from Rhiwlas only], SALTER (1845), in Geol. Journ., vol. i., p. 20; also p. 8. *Illænus crassicauda*, SHARPE (1848), Geol. Journ., vol. iv., p. 149.

Description.—Length 2½ to 3 inches. General form oval, very convex; length to width 17 : 10; the head and tail nearly equal in length; the thorax about two-thirds the length of either, and strongly trilobate; the axal furrows are carried less than half way up the head, and but a very little way into the tail: head a quarter of a sphere, and regularly convex, not peculiarly gibbous behind, where it is divided into three nearly equal parts by the slightly converging axal furrows; these curve out again opposite the eye. The eye is of moderate size, gently lunate, placed much nearer the furrow than the outer edge, and fully its own length or more from the posterior margin. There is no internal ridge at the place of the neck furrow. Facial suture divergent above the eye, and slightly so below it, so as to cut the margin beneath the most prominent curve of that organ. Rostral shield shuttle-shaped, covered by transverse, close, sharp lines, the lower edge a little produced and overhanging. Hypostome . . . . . ? Thorax of 10 narrow segments, the axis strongly marked, convex, and subfusiform; wider than the pleuræ in the forward segments, in the last only equal to them. The fulcrum is very near the axis in the first segment, and in the last one is placed less than half way along the pleuræ, which are sharpened anteriorly beyond this point. The anterior segments are bent down slightly, and also a little backward at the fulcrum, while the posterior ones are only bent downwards. Tail semicircular and moderately convex; the axis indistinctly marked out by two deep impressions, which sometimes form short rapidly-converging furrows; the upper corners are bent sharply down beyond the fulcrum, in order to pass freely under the thorax-rings in rolling; the incurved under portion is concentrically striate as usual, not broad nor indented by the termination of the abdominal axis.* General surface of the head not well known; a few wandering lines appear on one specimen near the margins of the cheeks; the thorax rings are unornamented: the general aspect is smooth.

Variations.—The axis in some specimens is narrower in proportion to the pleuræ (fig. 7).

Affinities.—This species requires close examination to distinguish it from several others. *I. Bowmanni* has only nine rings to the very short thorax. The *Ill. crassicauda* has a head very gibbous behind, and longer than the tail; the eyes placed at less than their own length from the neck margin, and remotely from the axal furrows; the tail, which has the axis distinctly marked all round, is scarcely longer than the thorax, and the latter has its axis broader and flatter than in our species; the fulcrum of the pleuræ not close in front, and at a full half behind; the incurved under portion of the tail is far broader and less concave, and its lines of growth meet at an angle in the middle; this last portion is, however, not always visible for the purpose of comparison. The whole surface, too, is covered with strong, sharp lines, which are certainly not conspicuous upon *Ill. Davisii,* though the latter is not quite smooth. *Ill. perovalis* (Murch) is a more elongate oblong species; the axis of the tail is very narrow, more so than in our narrowest variety, extends one-third down its length, and is circumscribed; the incurved portion of the tail is broad. It is not at present justifiable to connect even this latter with *Ill. crassicauda,* although it agrees more nearly with it than with any other species.

History.—Apparently it was not known till Professor Sedgwick and myself collected it at Bala, in what was then considered a peculiar band of limestone, and it was too hastily identified with the *Ill. Bowmanni* (Mem. Geol. Surv., vol. ii., part 1, pl. 8, figs. 1, 2, 3), and as such published in the list of Welsh fossils given in the 1st volume of the Geol. Journ., p. 20: the Rhiwlas locality belongs to the present species. Mr. D. Sharpe, in noticing the probable occurrence of *Ill. crassicauda* in America, states that this fossil is found at Rhiwlas; the present species only is intended, and Mr. Sharpe differs with me as to its specific value.

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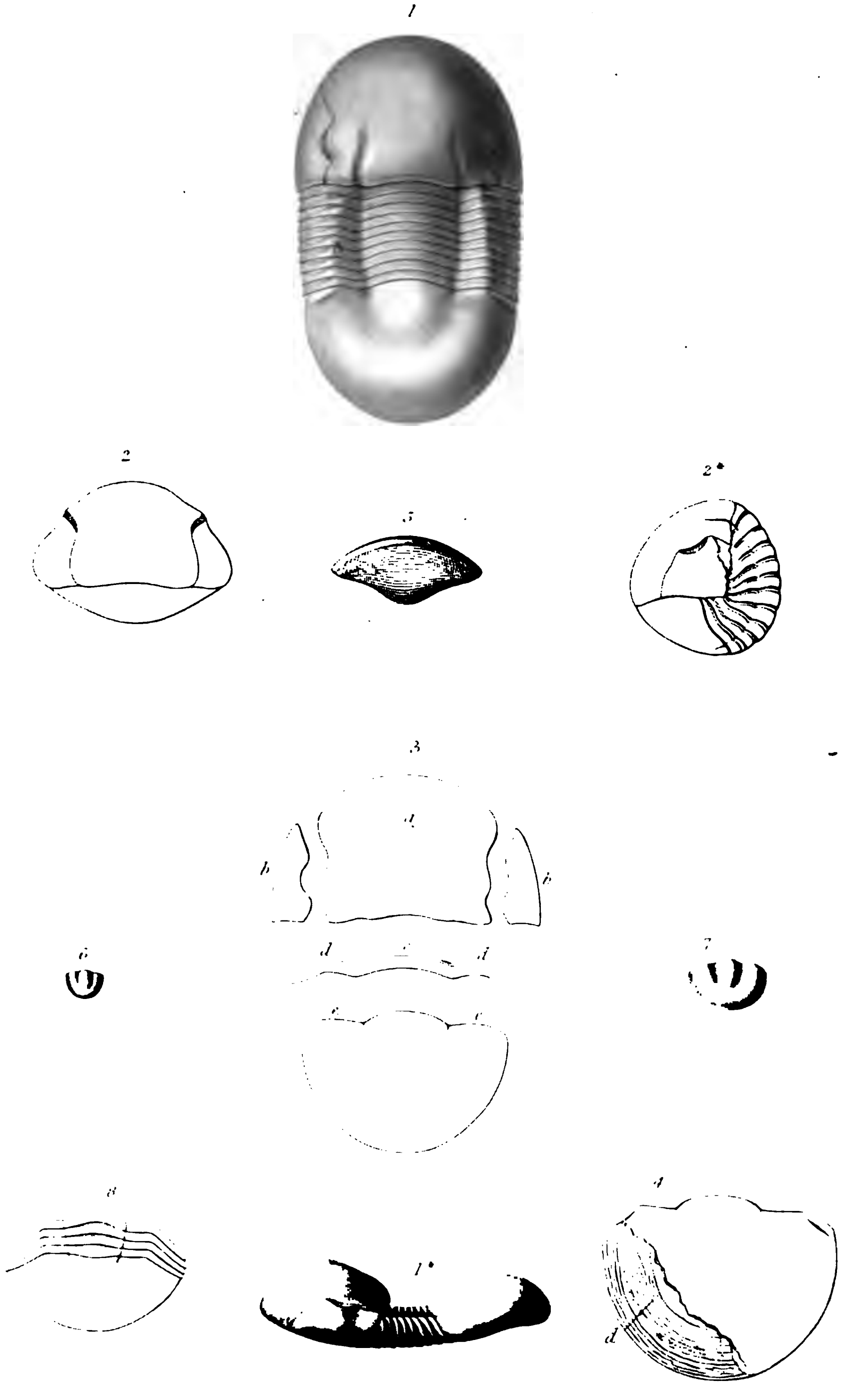
* This indentation is frequently to be seen in *Asaphus;* it is strong in *Illænus crassicauda,* Dalm.

DECADE [illegible]

Geological Survey of the United Kingdom.

ILLÆNUS
Silurian



ILLÆNUS DAVISII Salter

British Localities and Geological Range—LLANDEILO FLAGS only.—Abundant in the Bala limestone at Rhiwlas, at the foot of the lake, and also at other localities in the immediate neighbourhood both north and east of the lake (COLL. OF GEOL. SURVEY). It appears, however, to be but local, and its place is taken through many other parts of North Wales, and all through South Wales, by the *Ill. Bowmanni.* It probably occurs in the lower Silurian limestone of Wrae, near Broughton, Peebleshire; some fragments were found there by Mr. James Nicol (Geol. Journ., vol. iv., p. 206), which are with doubt referred to this species, as also is another portion of thorax found in the limestone of the Stincher river, Ayrshire, by Mr. Carrick Moore (*ib.*, vol. v., p. 13).

EXPLANATION OF PLATE II.

Fig. 1. Nearly perfect specimen. Rhiwlas, Bala; in which locality all, except figs. 6, 7, were found. Fig. 1*, side view of ditto.

Figs. 2, 2*. Front and side views of a rolled-up specimen; the want of gibbosity in the head is shown in the side view.

Fig. 3. Dissected figure. *a*, central lobe; *b b*, wings, upper side; they extend further inward on the under side; *c*, axis of a middle thorax segment; *d d*, fulcra; *e e*, fulcra of tail.

Fig. 4. A separate tail, showing the incurved under portion, *d*, where the upper crust is broken off.

Fig. 5. Rostral shield, often found separate.

Figs. 6, 7. Tails of young specimens, showing the further extension of the furrows at that age. Llechwedd ddu, Bala.

Fig. 8. Variety with narrow axis. The tail has been compressed from below, and appears too small. Rhiwlas.

British species of *Illænus* proper.

* With 9 body-rings.

1. *I. Bowmanni*, Salter, Mem. Geol. Survey (June, 1848), vol. ii., part 1, pl. 8, f. 1–3; *I. centrotus*, Portlock (1843), Geol. Rep., pl. 10, f. 3–6, and probably f. 9.

I. capite magno, angulis posterioribus obtusis; oculis remotis, ad marginem occipitalem approximatis; thorace caudâ breviore.

Locality.—Llandeilo flags, North and South Wales; Kildare, Ireland.

** With 10 body rings.

2. *I. Davisii*, as defined in our preceding description.

3. *I. Portlockii*, Salter; *I. crassicauda*, Portlock (1843), Geol. Rep. Tyrone, &c., pl. 10, f. 7, 8 [*Thaleops ovatus*, Conrad; Hall, Paleont. New York (1848), pl. 67, f. 6 *b*. ?

I. capite magno, cauda parva, subtrigona; oculis remotis [prominulis ?]; thorace segmentis 10, axi lato, pleuris abrupte deflexis et reflexis ad fulcrum, quod ad dimidium pleuræ uniusquisque positum est; caudâ depressa, subtriangulari, angulis extremis latè truncatis.

That this neat species is not *I. crassicauda* is very clear; the shape of the tail, and the abrupt backward bend of the pleuræ, almost at right angles, distinguish it easily; the fulcrum is as far outward in the first segment as the last, an unusual character. We have not seen specimens of *I. ovatus* (Conrad); Hall's figure of that species (loc. cit., pl. 67, f. 6 *b*) much resembles ours in the tail; but if his two specimens be correctly drawn, he must have figured two species under the name. We cannot therefore identify the Irish fossil with his, especially as the decided bend in the pleuræ is not given in his figure; and we dedicate the species to Col. Portlock, who has so well elucidated the trilobites of Ireland. Our description is drawn from his specimen.

Locality.—Lower Silurian rocks of Tyrone, Ireland.

4. *I. perovalis*, Murchison, Sil. Syst. (1839) t. 23, f. 7.

I. capite gibboso, oculis remotis; thorace quam caudâ longiore, segmentis 10, *axi angusto; pleuris paulo reflexis ad fulcrum, quod pleurarum ferè omnium ad tertium positum est, caudæ axi angustissimo, circumscripto.*

In the young specimen figured the eyes are not seen, but they must be nearly as distant from the axal furrow as the width of the central lobe; the axis of the thorax is much narrower than the pleuræ—this is maintained in the adult; the fulcrum at about one-third in the first segment, in the next a little farther out, and from thence at an equal distance in all the segments. Tail in youth more than a semi-circle, shorter than the thorax, with the axis very narrow, circumscribed, and reaching about half-way down; in the older state it forms about a semi-circle, is flattened, and the axis does not reach so far. The end of the axis does not indent the broadish incurved margin of the inferior side; it does so in *I. crassicauda*, which has a shorter and subtruncate convex tail, a much broader axis to the thorax, and the eyes not nearly so remote. We have not specimens perfect enough to characterize *I. perovalis* fully, but enough to show that it ought not at present to be connected with the Swedish species.

Locality.—Llandeilo flags of the Corndon Mountain, Shropshire.

5. *I. ocularis,*—*n. sp.*

I. capite semicirculari, utraque acutangulo, lobo centrali angusto; oculis magnis, approximatis, a cervice vix dimidium diametri remotis: thoracis axi pleuris æquali, his ad fulcrum deflexis et paulum reflexis; pygidio —— ?

A species so remarkable among the trilobed division of *Illænus*, for the size of the eye, that we have ventured to name it—we cannot recognize it among published species.

Locality.—Llandeilo flags, county Kildare, Ireland.

6. *I. Murchisoni*, Salter. *I. Rosenbergii*, ib., Mem. Geol. Surv., vol. ii., pt. 1, pl. 5, f. 6–8.

I. capite caudâque magnis, thorace brevi, anterius contracto; capite utrâque acutangulo, oculis ad sulcos approximatis, diametrum suum a cervice remotis; thorace axi latissimo distincto, pleuris anterioribus brevissimis.

A species connecting the true *Illæni* with *Bumastus*, having a very wide axis and very narrow front pleuræ. The axis, however, is really distinct, and the fulcrum not close to it. There is reason to believe that the *I. Rosenbergii*, to which these specimens were referred before, is a very large specimen of *I. crassicauda*: as Pander and Burmeister have previously stated. This fine *Illanus*, from near the classic town of Llandeilo, we dedicate to Sir R. I. Murchison.

Locality.—Llandeilo flags of Llandeilo, South Wales.

Notwithstanding its great similarity in external characters to *Nileus*, *Illænus* is essentially distinguished by the possession of a rostral shield, a portion so designated by Burmeister, and peculiar to *Illanus* and *Calymene*. This shield appears to be a plate inserted between the two cheek-pieces, and separates the hypostome, or labrum, from the facial suture. In *Asaphus* the cheek-pieces are united across, or in some divided merely by a vertical suture. *Ill. centrotus* (Dalman) has long head-spines, and in this differs from most species of the genus, though some others are angular at the corners. Pander, and after him Sars, described the hypostome; it is simply oval, and by no means notched, as in *Asaphus*.

The genus commenced in the Llandeilo flags, and continued to the end of the Silurian system. We think there is not good evidence of its longer duration, though Munster cites one or two species from Devonian rocks in Germany.

June, 1849. J. W. Salter.

BRITISH FOSSILS.

DECADE II. PLATES III. AND IV.

ILLÆNUS BARRIENSIS.

[Genus ILLÆNUS. DALMAN. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Family Trilobitæ.) Head about a quarter of a sphere; eyes smooth, remote; facial suture ending on the posterior margin behind the eye, marginal or submarginal in front; hypostome entire, separated from the facial suture by a transverse rostral shield; thorax rings 9 or 10.]

[Sub-genus *Bumastus*. Thorax with 10 rings, not trilobate; the axis very broad, reaching to the fulcrum.]

DIAGNOSIS. *I. (Bumastus) ovali-oblongus, valde convexus, crustâ crassa; capitis sulcis axalibus remotis; oculo magno prominente, vix dimidium longitudinis suæ a cervice remoto, palpebra* valde convexâ; thorace articulis* 10, *haud trilobato.*

SYNONYMS. "A new species of Trilobite," F. JUKES (1829), in Ann. Mag. Nat. Hist., vol. ii., p. 41, figs. 8, 9, 10; "*probably Isotelus*," J. D. C. SOWERBY, *ib.*, p. 45; SILLIMAN, Amer. Journ. of Science (1832), vol. xxiii., 1, p. 203. *Bumastus Barriensis*, MURCHISON (1839), Sil. Syst., pl. VII. *bis.*, fig. 3; *ib.* XIV., f. 7; EMMERICH (1839), Dissert. 33. *Nileus? (Bumastus) Barriensis*, MILNE EDWARDS (1840), Crust., vol. iii., p. 295. *Ill. (Bumastus) Barriensis*, BURMEISTER (1842), Org. Tril., 120; Ray edition (1846), 104. *Bu. Barriensis*, HALL (1843), Geol. Report, New York, No. 10, f. 4; No. 19, f. 2. [*Nileus glomerinus*, DALMAN, Arsberätt. (1828), p. 136; HISINGER (1837), Leth. Suec. 16?]

Description.—Oblong-oval and very convex; the three divisions, head, thorax, and abdomen, nearly equal. Head a quarter of a sphere, more pointed in front in the young specimen than in the adult, in which it becomes obtuse. The surface of the head is even, and but slightly marked by short converging distant axal furrows into glabella and cheeks. Terminating these short furrows, and immediately above the prominent upper eyelid (*palpebra*) is an oval space, sometimes flat of depressed, and sometimes a little convex, where the crust is thickened interiorly, and on which the puncta that occur so commonly on the other portions of the crust are absent in some specimens,—its nature we do not know. Eye strongly lunate, long, narrow, smooth, and supported by a very strong fold of the cheek, which forms a sort of lower eyelid, and is most developed in age. Cornea apparently thick. The facial suture in front of the eye runs S-shaped outwards and upwards, turns a little beneath the margin, and then runs straight across above the rostral shield; it bends out sharply beneath the eye, and cuts the margin beneath the most prominent curve of that organ. Rostral shield a long transverse piece, deeply striate, and overhanging with a sort of pouting lip the attachment of the hypostome. This last piece is yet undiscovered.* Cheeks with rounded angles posteriorly, and curving over the lower side of the head ; they are separated by the wide rostral shield.

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* Dalman uses the term "*lobus palpebralis*" for the covering plate or eyelid: its variations are often characteristic.

Thorax of 10 segments arched back, especially the forward ones, and having the three lobes just indicated by a very slight furrow where the fulcrum is placed, the subfusiform axis occupying more than two-thirds the entire width. The fulcrum is far outwards, and is formed by a short forward bend of each pleura, which then continues in the general direction, is sharpened anteriorly for rolling, and curves forward at its blunt end ; the foremost pleuræ are rapidly shortened, the whole of the cheeks projecting beyond them (plate 3, f. 1**a*).

Tail in the young about three-fourths of a hemisphere ; in the adult more than half. The upper corners are truncated and turned down, but there are no indications of the axal lobe. Incurved portion of the tail not broad, but thick, deeply concave, and marked concentrically on both surfaces by elevated lines of dots (pl. 4, f. 10, 10*a*). The whole surface of the animal is more or less punctate, and marked with wavy imbricate lines; they appear to vary very much in number and position, abound near the edges of the head, but less so on its most convex portion ; run across the thorax parallel to the course of the rings, and on the tail are most abundant on its forward margin. On all the articulating surfaces the lines are doubly close, but the puncta absent. On the somewhat depressed space immediately over the fulcral points in the head and thorax-rings, both lines and puncta vanish. These latter, which most probably indicate the bases of short pile, are often wide and deep (pl. 4, f. 3), and are present on the posterior surface of the tail, where the lines are absent. The inferior eyelid (pl. 3, f. 1**b*,, if so it may be called, is deeply punctate in our specimen, but without any of the wavy lines.

Variations.—Though numerous specimens are extant, there are so few perfect ones, that we are not able to detect any considerable variety in the proportions. Certain Dudley specimens appear more elongate.

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* Mr. John Gray of Dudley possesses an entire transverse labrum, with two tubercles, which very likely belongs to it.

Affinities.—But one is published which belongs to this section of the genus besides our own, the *Illænus trentonensis* of Emmons (Geol. New York, 2nd district), and through the kindness of Dr. Bigsby, the well-known explorer of the Canadian frontier, we have seen a specimen as large as our largest individuals of *I. Barriensis*, from Little Manitoulin Island, on Lake Huron. It differs, at a glance, from ours, in the angularity of the posterior angle of the head, and its strongly converging and lengthened axal furrows. Whether Dalman's *Nileus glomerinus*, described in 1828, be this species, as Burmeister thinks it may, we have no means of deciding at present.

History.—The earliest notice of the British fossil was given under the name of " A new Trilobite from Dudley," by Mr. Frederic Jukes, who communicated drawings and casts, and a note by Mr. J. de C. Sowerby, to Loudon's " Magazine of Natural History ;" the specimens were obtained from near Barr Beacon, Staffordshire. Mr. Jukes also communicated casts soon after to Silliman, for his " American Journal," and it is there stated that Mr. Sowerby had referred it to a genus found at Trenton Falls, the *Isotelus* of Dekay. Professor Green, however, would not admit the identity of the two genera, and denied the existence of the English type in America. This was quite true at the time, but it is singular enough that the Trenton limestone should afford afterwards another and almost identical species. Sir R. I. Murchison, as is well known, founded his genus *Bumastus* on this Wenlock fossil. Milne Edwards did not adopt it, and considered it closely related to *Nileus;* while, however, he referred the other species of *Illænus* to Dekay's genus *Isotelus.* Burmeister, in 1842, placed it in its present position as a section of *Illænus;* while the species of *Nileus*, which Dalman distinguished from all trilobites (not knowing our species) by their want of trilobation, have fallen into their true position among the large group of *Asaphus.*

British Localities and Geological Range.—SILURIAN ROCKS ; Woolhope limestone to Wenlock limestone. Wenlock formations of Hay Head, near Barr, Staffordshire (Sir R. I. Murchison). Dudley, Staffordshire. Haven, near Aymestry, Herefordshire (Rev. T. T. Lewis). Woolhope limestone of Littlehope, Woolhope ; and also of Nash Scar, Presteign, Herefordshire. Wenlock limestone of Ledbury, Malvern (Coll. Geol. Survey.)

Foreign Distribution.—Niagara group of New York (Hall). A species very like it was found near Hohenholm, by Eichwald (Urwelt, Russland, Heft, 2, 59), but it is not quoted from Norway or Sweden.

EXPLANATION OF PLATE III.

Fig. 1. Old individual from Barr, in the possession of Miss Jukes, of Birmingham.

Fig. 1*. Side view of the same, showing the shortened foremost pleuræ (*a*), and the inferior eyelid (*b*).

Fig. 2. Side view from a fine coiled specimen in the cabinet of John Gray, Esq., Dudley.

Figs. 3, 3*. Two views of a young one; in the cabinet of Augustus Lewis, Esq.

PLATE IV.

Fig. 1. The dissected figure. *a*, head; *b b*, cheeks; *c*, thorax segments; *d*, tail.

Fig. 2. Portion of surface above the eye, showing the wavy lines and puncta.

Fig. 3. Ditto, with puncta larger than usual.

Fig. 4. Magnified pleuræ, with lines and puncta.

Fig. 5. Part of tail, the puncta only present over the hinder portion of it.

Fig. 6. Pleura magnified, showing the fulcrum *a*, the backward bend at *b*, the sharpened forward edge *c*.

Fig. 7. Large head from Littlehope.

Fig. 7*. The same, lower side. *a*, rostral shield; *b*, rostral suture (Burmeister).

Fig. 8. Shows the thickened portion of shell just above the eyelid at *a*; impression of it on the stone beneath at *b*. (In this specimen it is destitute of puncta.)

Fig. 9. Side view of part of tail; at *a*, the fulcral point; *b*, the articulating surface, with lines, but not puncta.

Fig. 10. Incurved portion of tail; the inward surface with elevated granulate lines.

Fig. 11. A ditto, magnified.

The specimens figured in this plate are in the Geological Survey Collection.

The section *Bumastus* is related to the more typical species of *Illænus*, just as *Nileus*, of Dalman, is to his *Asaphus palpebrosus*. The distinct trilobation has vanished, and the axis is so wide as to reach the fulcral point, and be nearly coincident with it. There is a slight backward bend of each pleura just before the fulcrum, which serves to steady the articulation of the piece behind by overhanging it a little, while this piece, in turn, overhangs the preceding at the fulcrum, precisely as in the articulation of the abdomen of the lobster and cray-fish. Beyond the fulcral point the pleura is always more or less sharpened, to pass under the preceding joint in the act of bending; and, as in this operation, the back is lengthened, and the soft parts of the axis would be exposed by the separation of the segments, a convex articular portion is added on the forward edge of each segment, which fills the gap, and retires beneath the preceding joint, when the animal is extended. This is the structure of all trilobites which have been observed to bend or roll, and it is similar to that met with in recent crustacea.

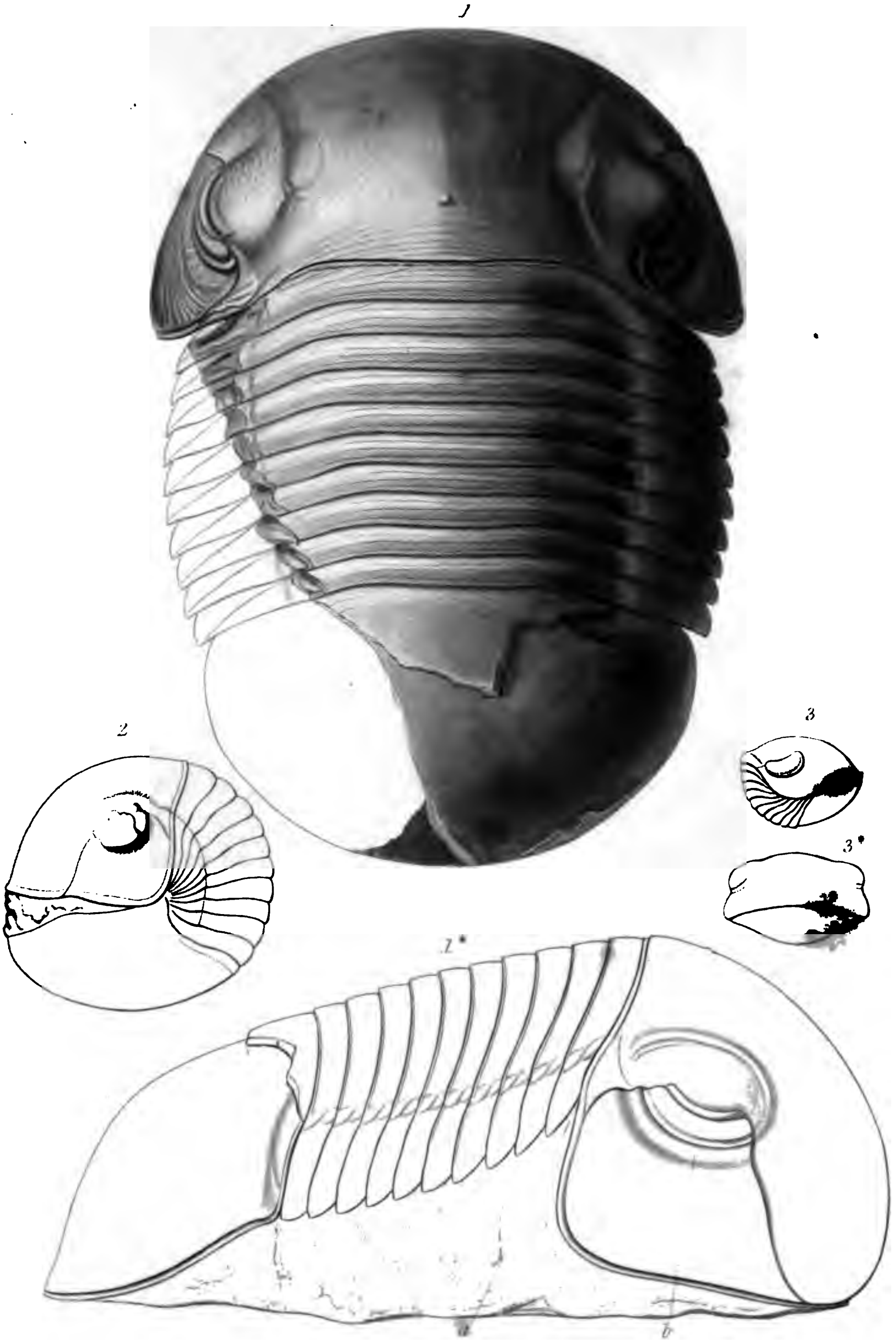
The subgenus is known in the Lower Silurian rocks of America, and the Upper Silurian of Britain.

J. W. SALTER.

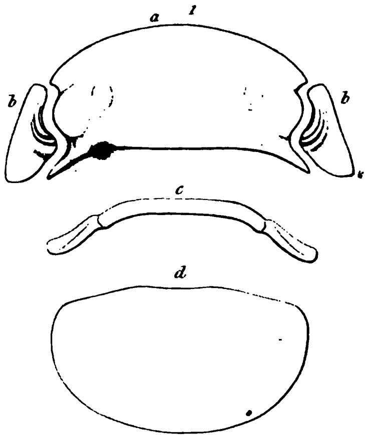
June, 1849.

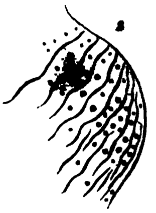
Geological Survey of the United Kingdom.

ILLÆNUS
(Silurian)



ILLÆNUS (BUMASTUS) BARRIENSIS _ *Murchison*


a
1
b
b
c
d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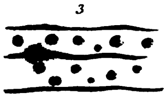
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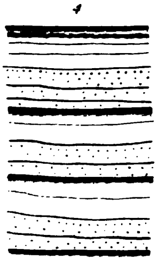
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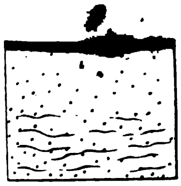
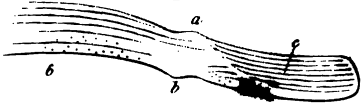
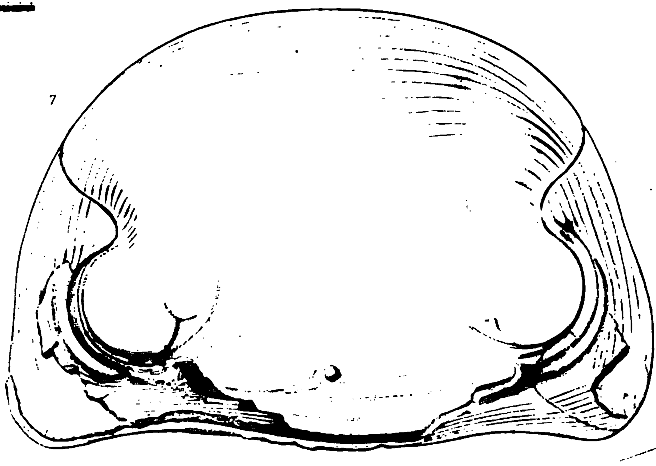



a
c
6
b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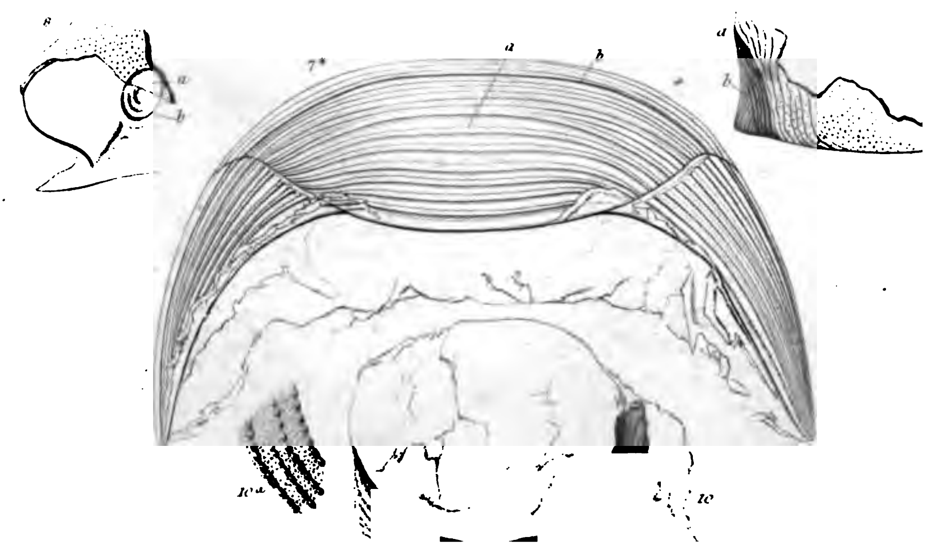
8
a
b
7*
a
b
9
a
b
10a
10

BRITISH FOSSILS.

DECADE II. PLATE V.

ASAPHUS TYRANNUS.

[Genus ASAPHUS. BRONGNIART. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Family Trilobitæ.) Eyes large, smooth. Facial suture marginal or supramarginal in front, and ending on the posterior margin. No rostral shield. Hypostome strongly bilobed. Body rings 8.]

[Subgenus *Basilicus*, Salter. Facial suture marginal in front; head but slightly lobed; pleuræ furrowed transversely; tail large, with axal and lateral furrows.

DIAGNOSIS.—*A.* (*Basilicus*) *ovalis; capite semicirculari, angulis in spinas breves productis; cauda parabolicâ, latè marginatâ, regulariter convexa, apice rotundato nec acuto; axi distincto, sublineari, angusto, multicostato, apice abrupto; lateribus multicostatis.*

SYNONYMS. *Asaphus Tyrannus*, MURCHISON, Silurian Syst. (1837), pl. xxiv. and pl. xxv., f. 1. *Ogygia Tyrannus*, EMMERICH, Dissert. (1839), 29. *Asaphus Tyrannus*, MILNE EDWARDS, Crust. (1840), 3, 310. EMMERICH, Leonhard and Bronn's Neues Jahrbuch 1845 (translated in 'Scientific Memoirs,' vol. iv. (1845), 273). [not of BURMEISTER, Organ. Trilob. (1843), t. 5, f. 4. Ray edition (1846), 108.]

A remarkably perfect specimen in the cabinet of W. Day, Esq., of Hadlow near Uckfield, and specimens in the Geol. Survey collections displaying the parts of the mouth, enable us to present a complete description of this famous, but apparently local trilobite.

Description.—Length 11 inches; breadth 6¾ inches. General form nearly a true oval, moderately convex; the head semicircular, the tail longer and parabolic. Head smooth, with a slight concavity marking off the margin, produced at the angles into short spines which reach the third thoracic segment. Glabella clavate, defined in front only; the forehead lobe large, protuberant, and nearly round: beneath it, and at the level of the front of the eye, is the uppermost of three obscure oblique furrows. There is at the base of the glabella a tubercle, and beneath it an impression marking the place of the neck furrow. Eyes rather large, much arched, placed behind the middle of the head, and close to the glabella; the base of the eyelid is constricted, the lentiferous surface is broad and smooth, and beneath the cornea there are very numerous lenses,* not quite closely set. Facial suture ending on the posterior margin, at the inner third of the width of the cheek, and in front of the eye turned outwards in a sigmoid curve ; it cuts the front margin beyond the parallel of the eye, and continues exactly along the edge of the shield.

The hypostome is semicircular at its base, which is moderately broad ; it has a squarish tumid centre surrounded by a strong furrow, and is deeply divided at the apex into two ovate-lanceolate forks, between which the shelly plate turns strongly inwards : there is an oval circumscribed tubercle at the origin of each, most distinct on the inner surface.

Thorax of eight moderately arched rings, the axis not strongly marked and as broad as the pleuræ ; these latter are furrowed for three-fourths of their length, and are curved down, but scarcely bent backward, at the obscure fulcrum, which in the hinder rings is placed at about one-third away from the axis, but much nearer to it in the forward rings ; the anterior edge of each pleura is sharpened, and its termination square.

Tail parabolic, its width at the broader end one-fourth greater than the length (it appears nearly equal), regularly convex, not sunk in the middle ; axis flattened forwards and prominent behind, terminating abruptly at four-fifths the length of the tail, and ribbed throughout by about 15 furrows. The sides are furrowed for about half their width by 12 or 13 oblique parallel sulci, which end abruptly at the edge of the broad concave margin ; the uppermost furrow is much stronger than the rest. The incurved lower surface of the tail occupies rather more than the breadth of the smooth upper border, and folds round the end of the axis which indents it. The fine lines on this incurved border are not truly concentric with the edge, but appear to branch from an imaginary line along the middle or most concave part. The space left between the upper and lower borders is shallow. On the upper crust of the tail the wavy lines are interrupted and inosculate ; they arch over the axis with the convexity of the curve forwards : on the lateral lobes the curve is reversed.† The same arrangement is seen on the thorax rings,—at the ends of the pleuræ they turn upwards, and fig. 8 shows the longitudinal disposition of these lines on their under sides. On the head similar lines occur, but we have not specimens to show it well ; the hypostome has them obliquely on the forks (fig. 4).

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* On a specimen lent by Mr. Day, which presents only the lower half of the eye, the number and arrangement is such, that judging from analogy with *A. Powisii*, the eye of which is very much like this, there must have been 6000 lenses, or probably more.

† Burmeister has figured a good example of this arrangement of the sculptural lines on the tail of an *Asaphus* in his "Zeitung fur Zoologie," &c., 1 Band, 1848, t. 1, f. 19.

Variations.—Some individuals (perhaps females) are much more convex than others; in some the margin is abruptly concave; our figured specimen is depressed. The number of lateral ribs to the tail varies considerably, they do not seem to become more numerous by age. The forks of the hypostome are long or short. The ornamental lines which are so conspicuous in the external cast (Pl. 24, Sil. Syst.) exist, though less deeply sculptured, in all; the internal cast, which is more commonly found than perfect specimens, does not show them distinctly.

Affinities.—The specimen figured in Burmeister's work appears by his description to have been from a "boulder of red limestone," and hence it is very probably a worn specimen of *A. heros* (Dalman), from the red limestone of Kinneküllc, Gothland. It is unfortunate that the author should have transferred the sculpture of *A. tyrannus* to this figure, for the axis is constricted in the middle and depressed, and the lateral ribs long; it is in fact a pretty good figure of *A. heros*, except in the rounded tail; in Swedish specimens the tail is pointed and the axis percurrent. There is also a species in the lowest Silurian limestone of New York so like ours, that we do not know how it is distinguished; there are, however, but seven or eight distinct ribs on the axis, and those on the sides are said to be duplicate; we refer to *A. marginalis* (Hall), described in the Palæontol. New York. This is the more interesting, as the *Asaphi* of North America belong generally to the group *Isotelus.** The species which most nearly resembles *A. tyrannus*, and which I referred to it in Prof. Sedgwick's papers in the "Geological Journal," is the *A. Powisii*, very common in the slates of North Wales. The specimen of this latter species figured in the "Sil. Syst." is much compressed, for the species is really more convex than that here described, with deeper furrows on the pleuræ, which are arched forward at their ends; and the tail axis is wide above, rapidly contracting in width and becoming quite indistinct, its end only prominent; the surface seems smooth; the sides of the tail have a very strong uppermost furrow; the remaining furrows are faint. Fine specimens of *A. Powisii*, in the collections of the Geol. Survey and of Mr. Sharpe, show very numerous lenses (about 7000) on each eye.

History.—It appears not to have attracted the notice of Llhwyd, although it is quite as common at Llandeilo as the *Ogygia Buchii*, of which he figured specimens; nor does it seem to have been noticed by any writer on trilobites previously to the publication of Sir R. I. Murchison's work. Emmerich, in his Dissertation, showed how close he considered its affinities to be with *Ogygia*, by transferring it to that genus. In 1845, however, he restored it to *Asaphus*, though he evidently had not observed the characteristic labrum. Burmeister appears not to have been acquainted with the species, since in both editions he confounds it with what we believe to be a specimen of *A. heros*, and even suggests, in his Appendix, that Murchison's smaller figure might prove to be *A. extenuatus*. He notes that it appears anomalous for *Asaphus* to have such distinct ribs on the tail; and indeed this peculiarity is one of the indications of its affinity to *Ogygia*, which we think confirmed by the course of the facial suture.

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* The young animals of even this group, according to Hall's figure, are trilobed and ribbed in the tail; but that can only be in a very young state.

Localities and Geological Position in Britain.—LLANDEILO FLAGS.—Limestone of Wrae, Peebleshire? (Geol. Society's Coll.). Coniston limestone, Westmoreland? Craig-y-Glyn, Berwyn Mountains, in Bala limestone (Sedgwick); Meadow Town; Shelve, &c., in the Longmynd, Shropshire; Carneddau Hill, Builth, Radnorshire [J. W. S.]; Llandeilo, and many neighbouring localities in Caermarthenshire; Llampeter Felfry, Pembrokeshire [Murchison]; Narberth; Mydrim; Sholeshook; Lann Mill, Pembrokeshire (Phillips). It is remarkable that it does not occur in Ireland.

Foreign Distribution.—It is quoted by Sir R. I. Murchison from Northern Europe [Quart. Geol. Journal], but with the understanding that *A. heros*, Dalm., was intended. *A. marginalis*, Hall [Palæont. New York, pl. 4, *bis*, f. 15], may be the same as our species.

EXPLANATION OF PLATE V.

Fig. 1. Perfect specimen. Llandeilo. (Collection of W. Day, Esq.)

Fig. 2. Outline of central portion of head, showing the constricted eyelids. Lann Mill.

Fig. 3. Portion of head, with the base of the eye, *a*. Llandeilo (Mr. Day's Collection).

Fig. 3*. Magnified portion of a cast from the same, which would represent the surface of the eye when the smooth cornea is removed.

Fig. 4. Perfect hypostome, with the upper processes (*a a*). Lann Mill.

Fig. 5. Variety of the hypostome, with shorter forks. Golden Grove.

Fig. 6. Punctate exterior surface of part of hypostome; the lineated surface is shown in fig. 4.

Fig. 7. Upper surface of a thorax joint. St. Clears.

Fig. 8. Under surface of ditto, showing the extent of the incurved portion *b*, *b*.

Fig. 9 Part of thorax of a large individual, with deep sculpture. Golden Grove, Llandeilo.

Fig. 10. Tail of young individual. Llandeilo.

Fig. 11. Incurved part, under side of the tail, bounded by the lines *a*, *a*, and deeply indented by the axis. Clog-y-frain. (Sir R. I. Murchison's Cabinet.)

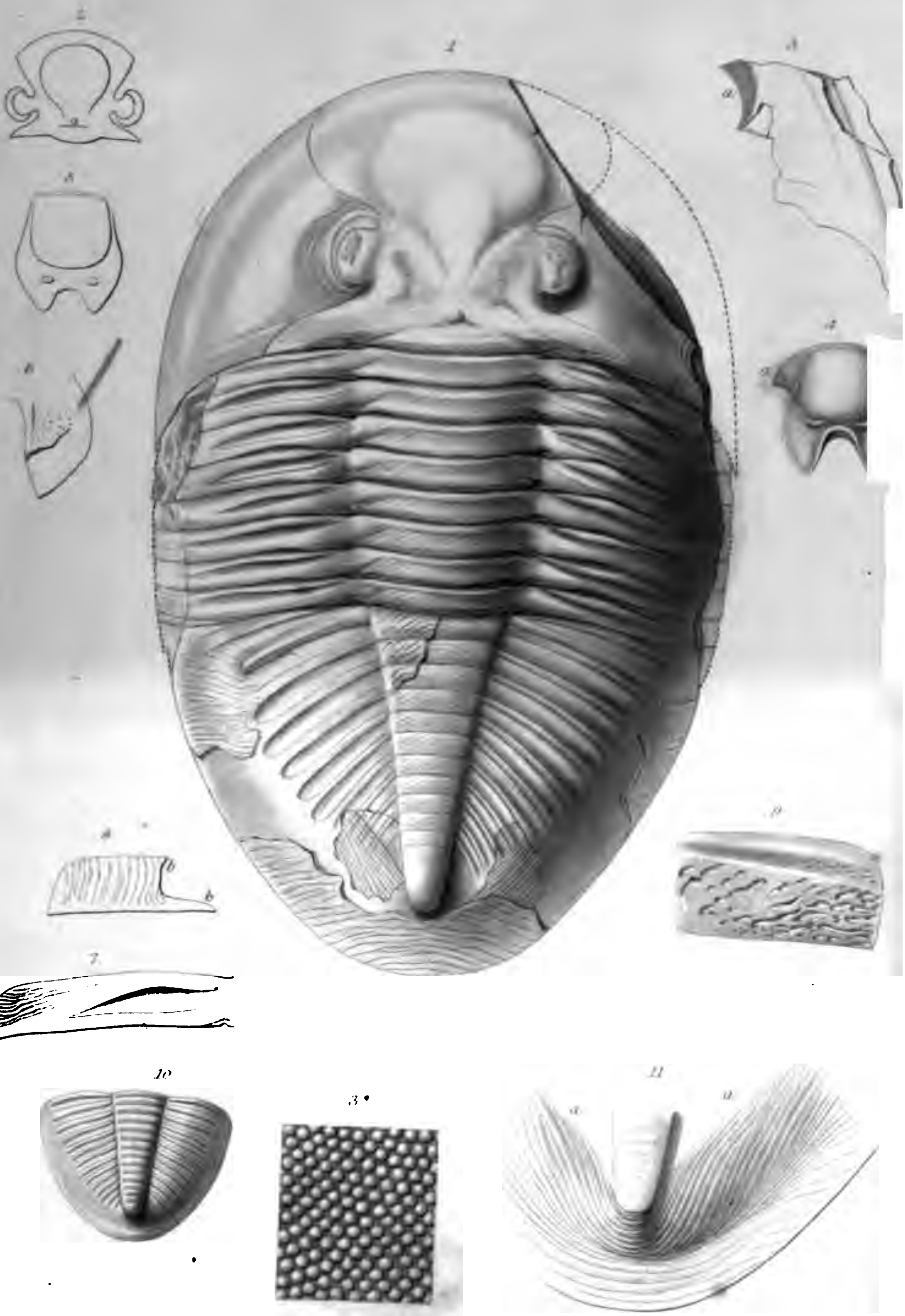
June, 1849. J. W. SALTER.

Geological Survey of the United Kingdom.

DECADE 2. PL. 5

ASAPHUS

(Silurian)



ASAPHUS TYRANNUS, *Murchison.*

E. Forbes direx.

BRITISH FOSSILS.

DECADE II. PLATE VI.

OGYGIA BUCHII.

[Genus OGYGIA. BRONGNIART. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Family Trilobitæ.) Eyes large, smooth; facial suture cutting the posterior margin; no rostral shield or vertical suture; hypostome entire; body rings 8; tail large.]

DIAGNOSIS. ***O. ovalis, glabellâ angustâ utrinque quinquesulcatâ; oculis ad medium capitis; suturâ faciali ad frontem marginali; spinis posticis brevibus; hypostomate obtusè acuminato; thoracis axi bis pleurâ angustiore; caudæ axi longo abrupto; sulcis lateralibus* 12 *duplicatis, prope marginem angulatim deflexis.***

SYNONYMS. **LLHWYD (1698), Philosoph. Transact., vol. xx., 279, tab. addit., f. 15. *Buglossa curta strigosa*, ib., Ichnograph. Brit. (1690), Epist. 1, t. 22, f. 2. Trilobite from Llanelly, PARKINSON, Organ. Rem. (1811), v. iii., t. 17, f. 13. *Asaphus De Buchii*, BRONGNIART, Crust. Foss. (1822), t. 2, f. 2. *Trilob. De Buchii*, SCHLOTHEIM, Nachtr. (1823), ii., 34 (excl. the locality, "Norway.") *Asaph. Buchii*, Dalm. Palead. (1826), 68.** J. D. C. SOWERBY, in Loudon's Mag. Nat. Hist., 1829, vol. ii., f. 27. BUCKLAND (1836), Bridgwater Treatise, t. 46, f. 7. MURCHISON (1837), Sil. Syst., t. 25, f. 2. QUENSTEDT, Wiegm. Archiv. (1837), vol. iii., 1, 346. EMMERICH, Dissert. (1839), 28. MILNE EDWARDS, Crust. (1840), 3, 309. BURMEISTER, *Org. Trilob.* (1843), t. 1, f. 2, [facial suture wrongly figured.] Ray edition (1846), p. 59. CORDA, Böhm. Tril. (1847), t. 4, f. 39 [bad.]

——JUNIOR. *Trinucleus? asaphoides*, MURCHISON, Sil. Syst., t. 23, f. 6. MILNE EDWARDS, Crust., v. iii., 333.

Description.—Length occasionally near seven inches, generally three or four; proportion of length to breadth from 6 : 5 to 6 : 4, a considerable variation. General form a broad depressed oval, the head nearly semicircular and as long as the thorax, the tail semi-elliptical and longer than either; glabella at its base occupying one-fourth or less of the width of the head, broader and more convex above, and a little pointed in front; it extends nearly to the front margin, and is marked, a little within each side, by a longitudinal depression, which is curved with the convex side inwards. Along this hollow lie five pits, which represent the glabella furrows; the basal one is the neck furrow, that above is placed near the centre of the glabella, the other three recede more, the uppermost coming just above the eye. Eyelid large, semicircular, and not touching the glabella. The facial suture above the eye is curved outwards a little to reach the margin, along which it runs for some distance; beneath the eye it curves largely outwards, and cuts the posterior edge just within the border. The latter is wide and striate, more or less concave, and marked off by a distinct marginal furrow. Eye placed halfway up the head, smooth, the lentiferous surface broad, its minute structure is not yet known. Head angles not produced below the fourth body segment. Hypostome broad above, narrowing below, where it is suddenly and obtusely pointed; the centre is gently raised, and a furrow runs down each side; there are two transverse furrows near the apex, with compressed tubercles between them. Thorax with the axis gently convex, variable in proportion, but seldom more than half the width of the pleuræ. These are flattened, furrowed along the upper margin as far as the fulcrum, at which there is an obtuse bend (fig. 2, *c*, *c*), the furrow diverges from the margin here, and does not quite reach the recurved and pointed extremity; it becomes widest immediately beneath the fulcrum, and from the lower margin of the pleuræ at this point a narrow ridge runs obliquely upwards, and meets it. Tail varying from little more than a semicircle to a half-ellipse, very gently convex; the axis gently tapering, ribbed by about 13 or 14 furrows, which have a downward bend in the middle; its obtuse tip projecting. Lateral furrows at nearly right angles to the axis, angularly bent downwards at the place of the fulcrum,* interlined all the way by fainter furrows, and leaving but a narrow flat margin. Incurved under portion of the tail narrow, closely striate, not indented by the axis; the upper side has a striate band of the same width, which is indented by every rib of the tail. The inferior striated band is continued (of the same width) along the ends of the pleuræ, and the striæ run in the same direction, while, on the upper surface, they are transverse, and reach further inwards. Numerous fine striæ, arched upwards, cover the axis. The cheeks appear to be nearly smooth, but the glabella is covered by fine, short, broken, almost microscopic lines. The hypostome is strongly and concentrically striate.

Variations.—It varies in convexity, proportionate length, and in the width of the axis; this latter is sometimes, though very rarely, more than half the breadth of the pleuræ—generally half, frequently less than half. A pair of tubercles on each segment of the axis is present; they are distinct and strong in some specimens (fig. 6), and faint in others.

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* The tail, consisting of anchylosed segments, preserves traces of nearly all the characters of the thorax; the strong furrows are analogous to the furrows of the pleuræ, the fainter lines between them to the joints.

Affinities.—From *O. Guettardi* it is known by its less elongate and more oval shape, and greater width of pleuræ in proportion to the axis; in *O. Guettardi* they are but once and a-half the width. The axis of the tail is longer, and has 13 instead of 9 ribs, and is abrupt, not attenuated at the tip;—in *O. Guettardi* it extends but three-quarters the length. It has, also, duplicate, bent, and more numerous side furrows; the other has but eight or nine straight simple ones; the hypostome also is subconical, not dilated laterally. *O. dilatata*, Brunnich (not of Portlock), which seems to have been frequently held as a variety of *O. Buchii*, has the glabella short, with its lobes crowded down towards the lower part, and the eyes remote. The facial suture behind the eyes appears much less arched in Sars' figure. He also describes the tail as with 10 ribs, separated by *broad* furrows. The labrum of *O. dilatata*, according to Sars' figure, is but slightly different from that of the British species; but an important difference resides in the facial suture, which, in *O. dilatata*, is within the front margin on the upper side, but in *O. Buchii* is along the edge itself, as in *Asaphus Tyrannus*.

History.—The earliest mention we can find of Trilobites is concerning this species, and is that which all writers on these fossils have quoted. Mr. Edward Llhwyd, in a letter to Dr. Martin Lister, of the Royal Society (1698) writes "concerning several regularly figured stones lately found by him." "The 15th," he says, "we found near the Lhan Deilo*, in Caermardhinshire, in great plenty, it must, doubtless, be referred to the sceleton of some flat fish;" but, a few lines after, "Not that these, or any other marine terrestrial bodies were really parts of exuviæ of animals, but they bear the same relation to them as fossil shells to marine ones," &c. This latter opinion he takes care to maintain in his "Lithophylacii Brittanici Ichnographia" (1699), where he again says, the specimen represents only the skeleton of a sole fish, and wants the tail, and he marvels that the "Piscis Icon" should be raised above the surface of the stone, "ac si verus piscis esset." It is curious that Brongniart should have placed this species in his heterogenous group *Asaphus*, at the very time he was founding *Ogygia*, as he appears to have recognized the latter genus more by its marked habit than by any positive characters. He probably meant to unite *A. dilatatus* with *A. Buchii*. Dalman distinguished them, but with doubt, in 1826, and gave a figure of the Norwegian fossil from a plaster cast; and had not Sars, in 1835, given a complete description, and a good figure of the head, the identity might still have been maintained. The hypostome of this species was first represented in Sir R. I. Murchison's figures. We have ascertained, by personal inspection, that the *Trinucleus Asaphoides* of his work is the young of *O. Buchii.* Quenstedt, 1837, unfortunately got hold of two specimens with seven rings; whether an accidental variety, or as Burmeister thinks, one occasioned by the slipping of one ring under the others, it is difficult to say. Quenstedt, however, relied on these, and Dalman's 7-ringed specimen of *O. dilatata*, and asserted the same number for *O. Guettardi.* But the error in both cases led him to see the generic affinity between these two allied species, and he distinctly says that their union with the typical *Asaphi* is unjustifiable. Burmeister, in his first edition, set the number of rings right, but confounded *O. dilatata*, which Sars had well distinguished in Oken's "Isis," (1835), with our species, and adhered to this view in the Ray edition (1846). Emmerich had, in the mean time, spoken of them as different species, and figured *O. dilatata* in Leonhard and Bronn's "Neues Jahrbuch," for 1845. Corda still maintains the error of the seven rings.

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* Fig. 9, of the same communication, is often quoted as belonging to *Trinucleus*. We have no doubt it is *T. Caractaci*, as that is the common species there (*T. fimbriatus* is found at Builth) besides, the distinct dots in the fringe identify it with the former species. Fig. 8 appears never to have been quoted, yet it is a tolerable representation of *Cybele verrucosa*, Dalman, and it has been figured again without a name by Brongniart, plate 4, f. 11, from the same locality, where it abounds, and is the only species of the genus there.

British Localities and Geological Range.—LLANDEILO FLAGS only. Not yet known in North Wales; the localities given for it in the "Geol. Journal," vol. i., p. 20, &c., are erroneous, and were stated to be so in vol. ii., p. 128. It abounds in the distorted slates at Shelve and Hope Mill, Shropshire (Sir R. I. Murchison); Rorrington, Middleton, and Meadowtown, Shropshire; Builth, Radnorshire; Llangadoc and Llandeilo, Caermarthenshire (Geol. Survey Coll.) Haverfordwest; Musclewick Bay, Pembrokeshire (Phillips).. Not yet found in Ireland.

Foreign Distribution.—La Couyère, Bain, &c., near Rennes, in the Cotè d'or (M. Rouault). In the north of Europe *O. dilatata* takes its place.

EXPLANATION OF PLATE VI.

Fig. 1. Perfect specimen from Builth (the glabella hardly pointed enough in front).

Fig. 2. Same specimen dissected; at *a* the slight ascending furrows which cross the neck segment are seen; *b b*, cheeks or wings; *c c*, fulcral points of the pleuræ; *d*, tail.

Fig. 3. Under side of head in front, with the hypostome *b* attached to the continuous under portion *a* of the cheeks; Builth.

Fig. 4. Young specimen from Builth.

Fig. 5. Border of the tail, the inflected striate portion rendered wavy by projecting further inwards on each rib.

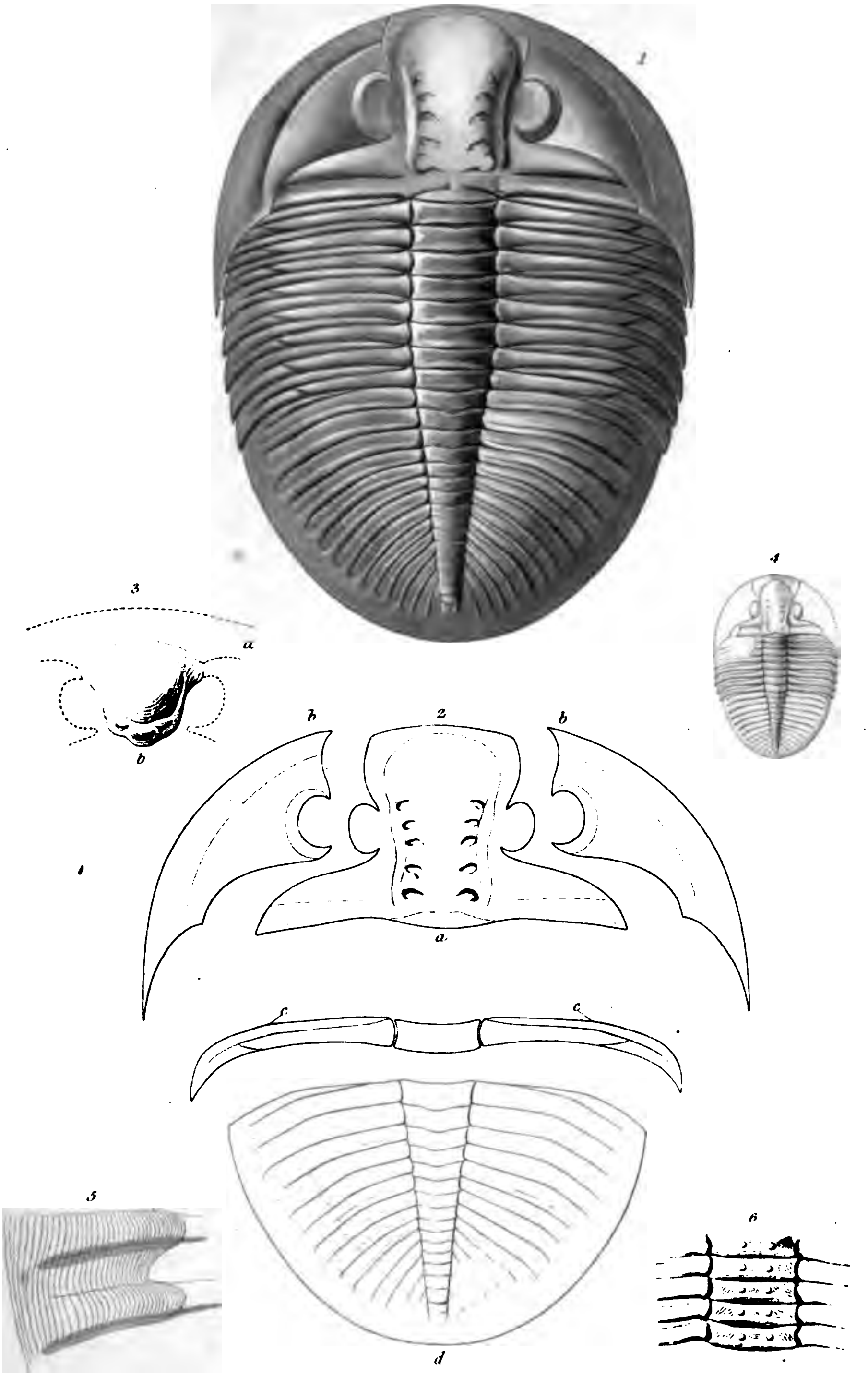
Fig. 6. Variety, with the tubercles on the axis strong; Llandeilo.

All the specimens in the Geological Survey Collections.

June, 1849. J. W. SALTER.

Geological Survey of the United Kingdom.

OGYGI.
(Silurian)



OGYGIA BUCHII. _ *Brongniart*.

BRITISH FOSSILS.

DECADE II. PLATE VII.

OGYGIA PORTLOCKII.

[Genus OGYGIA. BRONGNIART. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Family Trilobitæ). Eyes large, smooth; facial suture cutting the posterior margin; no rostral shield or vertical suture; hypostome entire; body rings 8; tail large.]

DIAGNOSIS. *O. ovali-oblonga ; capitis margine angusto; glabellâ genis latiore, obscurè lobatâ; oculis ad anteriorem partem capitis positis; sutura faciali ad frontem marginali; caudæ axi lato brevissimo.*

SYNONYMS. *Asaphus dilatatus*, PORTLOCK (1832), Geol. Rep., Tyrone, &c., pl. 24, f. 2 (not of Dalman). *Ogygia dilatata*, PHILLIPS, Memoirs Geol. Survey (June, 1848), vol. ii., pt. 1, 239.

Description.—Length 3½ inches; width 2½ inches; often larger. General form nearly flat, ovate, widest in front. Head forming rather more than a semicircle, considerably longer and wider than the tail, but about as long as the thorax; the glabella is as wide as the cheeks below, and separated by slight furrows from them; it widens and overhangs the eyes above, and is abruptly bent down in front, where the margin is hardly visible. For nearly two-thirds of its length the glabella is marked by lateral furrows, irregular in direction, dividing it (apparently) into four lobes, exclusive of the forehead and neck lobes. The neck lobe *b* is broad, and rises higher on each side than in the middle; it has two oblique sunk lines, *c c*, rising from the lower angles, which appear to divide it into a pair of lobes (*O. Buchii* has the same marking). Above this lobe lies the more contracted basal one *g*, which does not reach to the margin of the glabella. The second lobe, *h*, is wider and more oblique than the third, *i*, which is very faintly divided from the wide transverse forehead lobe *a*. The fourth lateral lobe, so distinctly marked in *O. Buchii*, is absent in this species. Eyes moderate, placed very high up, towards the termination of the facial suture on the margin; eye-lid semi-lunate, but not constricted above or below; eye line turning a little out above the eye, beneath it obliquely downwards and outwards, cutting the posterior margin at about half the cheek's width; wings moderately large, with a narrow border and a small spine. Hypostome with the centre gently swelled, and with distinct concentric furrows on the sides; apex . . . . . ?

The first and last thorax rings are somewhat narrower than those of the middle; the axis is widest at top, and there only a little narrower than the pleuræ. It is not arched, but flattish, and marked by indistinct tubercles on the sides and middle. The pleuræ are straight; the fulcrum indistinctly marked about half-way along them; the divisions between the segments not nearly so conspicuous as the oblique straight furrow which reaches nearly to the end of each. The ends of the pleuræ are recurved and pointed, the foremost ones perhaps not quite so strongly as in our larger figure, the hinder ones as much as in fig. 2*.

Tail a semicircle, with the upper angles rounded off; the axis hardly more than two-thirds the length, flattened, conical, the end a little pointed. There are about five distinct ribs on the axis, each obscurely trituberculate. Lateral furrows four or five, very oblique, the two uppermost sharp and deep, reaching more than half across the side, with a secondary one between them, the two or three last very short and faint. Margin flat. Whole surface of tail crossed obliquely by lines which all run down from the upper angles inwards, except near the edge, where they are concentric; the incurved portion of the tail concentrically striate, broad, and indented by the axis. On the pleuræ the lines are longitudinal, and form a broad band crossing the segments. We do not know their direction on the head; the hypostome, however, is strongly marked by raised concentric threads.

Variations.—In the young state the middle lobe of the thorax and tail is narrower (of the latter considerably so), and therefore longer proportionally than in the adult; thus, in our smallest specimens, fig. 3, the pleuræ are once and a half as wide as the axis; in fig. 4, which is older, nearly as wide in proportion. In this stage the tail axis is not visibly annulated, but the number of lateral ribs is the same as in older specimens, about four; the upper one is not, however, duplicate. The glabella in the youngest specimens is very obscurely lobed, and the eyes are thrown even further forward, close to the very narrow border in front of the glabella. The latter is not incurved in front.

The most interesting point about these young *Ogygiæ* is, that they appear to confirm the supposition of the number of segments increasing with age. Fig. 3, the youngest, has but four segments to the thorax, and there is no appearance of displacement, the head is not shifted at all. In fig. 4, a little older, there are seven rings, nor can we think there is displacement in this case. The tail has turned a little, as on a pivot, pushing the front edge on one side a little under the last ring, but it has opened from that ring on the other side. Had a ring been shifted off, and lost in the stone, we might have expected to see an

Geological Survey of the United Kingdom.

OGYGIA
(Silurian.)

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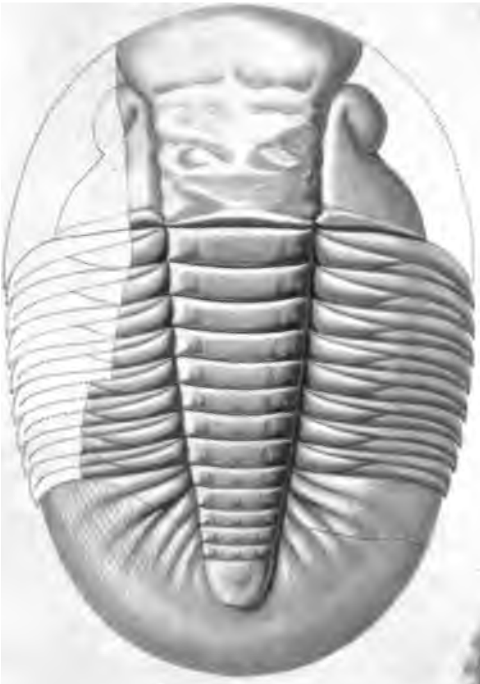

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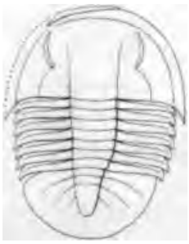

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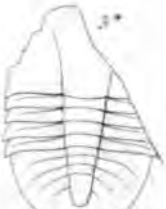

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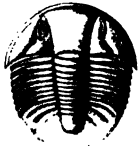

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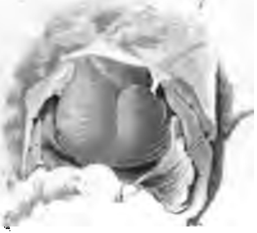

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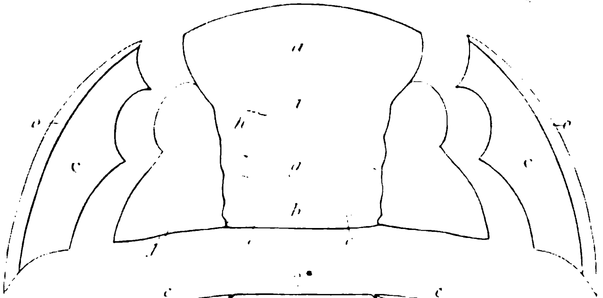

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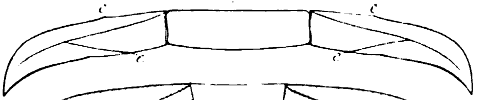

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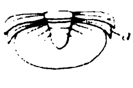

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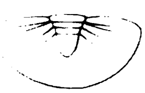

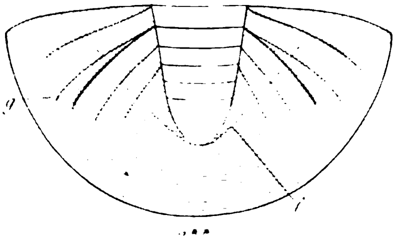

2**

OGYGIA PORTLOCKII, *Salter.*

impression of part of it on this exposed side—but there is none. And the probability that we have in this case the whole number of rings is strengthened by observing what takes place in one a little older, fig. 5*, for in this the last segment is very narrow, and appears to be in course of development.[*] We have no perfect very young specimens of *O. Buchii*, and therefore the point is still open to observation in this genus, in which occasional specimens have certainly been found with seven rings, as noticed by Quenstedt, Dalman, and Burmeister. The usual number is eight.

Affinities.—Its identification with *O. dilatata* by its discoverer, Portlock,[†] is easily understood by reference to his very imperfect original specimen, which he saw clearly was distinct from *O. Buchii*. With Dalman's figure, too, there is more similarity than with the better figures published since by Sars (Oken's "Isis," 1835), and Emmerich ("Scientific Memoirs," vol. iv.) Our species differs from the Swedish one essentially in the broad glabella, narrow head margin, and forward eyes. The proportions of the caudal axis and the lateral ribs of the tail are altogether different, but the above-mentioned characters of the head will suffice.

British Localities and Geological Range.—LLANDEILO FLAGS. Large and fine specimens were obtained in abundance at Newtown Head, Waterford; smaller ones are common at Builth, Radnorshire.

Foreign Distribution.—Not known. Dalman's figure of *A. dilatatus* is more like our species than the representations given by Sars and Emmerich, but we take it for granted these authors figure Brunnich's species, as their specimens were from Christiania.

EXPLANATION OF PLATE VII.

Fig. 1. Large, but not full-grown individual. Newtown Head, Waterford.

Fig. 2. Same, or similar specimen, dissected.

[The letters on the head are placed in the order of those in the Mem. Geol. Survey, vol. ii., pt. 1, p. 334.]

a, Forehead, or front lobe; *b*, neck lobe, traversed by a pair of oblique lines *c c*, which mark the extent of the articulating surface of the first thorax joint; *g*, basal, or first lobe; *h*, middle, or second lobe; *i*, upper lobe, third; *j*, posterior margin, or lateral neck lobe; C, free cheek, or wing; *o*, margin.

Fig. 2*. Thorax ring of ditto; *c c*, place of fulcrum; *e*, an oblique line running up wards to the furrow (as in *O. Buchii*).

[*] We believe this increase in number is not a solitary case. The figured specimen of *Trinucleus Lloydii*, Murchison, has but five rings, and seems perfect. It may be peculiar to certain genera. Burmeister has suggested it in the case of *Paradoxides bohemicus*.

[†] We have great pleasure in dedicating the new species to Lieut.-Col. Portlock, whose careful and elaborate treatise on the Irish trilobites will be always valued by the British student. It was not only the best, but, at its publication, was the only English work containing extended views of the generic affinities.

Fig. 2**. Tail of ditto; *f*, line marking the edge of the thin incurved portion of tail [the lines that cover the tail in this figure are those of the upper surface]; *g*, intermediate furrow between 1st and 2nd.

Fig. 3. Youngest specimen, with four body rings. Builth.

Fig. 3*. The same magnified, to show the narrow caudal axis.

Fig. 4. One rather more advanced, with seven body rings. Builth.

Fig. 4*. The same, &c., magnified; shows the tail a little turned aside.

Fig. 5. Still older; the eyes very forward; eight rings. Builth.

Fig. 5*. The same, magnified: shows the last thorax segment as yet imperfectly developed *a*.

Fig. 6. Specimen of intermediate size, with short axis. Waterford.

Fig. 7. Imperfect hypostome; *a a*, concentric furrows. Waterford.

Note on the Genus.

The near affinity of *Ogygia* with *Brontes* has been perceived by Emmerich, who, in his excellent paper, "On the Morphology and Classification of Trilobites," * placed it next to that genus. The number of segments differs, 10 for *Brontes*, 8 for *Ogygia; Brontes*, too, is sometimes very convex, while *Ogygia* is flat; the shape of the glabella and caudal axis differ materially, and there was no genus known which could fill up the interval between the two genera. Both are expanded forms, characterized by large and strongly radiated tails, and flattened glabellæ, and by an obtuse, entire, furrowed hypostome. We are, therefore, fortunate in being able to publish a species of *Ogygia* whose characters link the genera much closer than before, and which, perhaps, might be regarded rather as a new generic form, but that its habit is quite that of *Ogygia*. If we knew more species of the genus, we would propose sub-genera for it, and might divide it into—

1. Glabella indistinctly lobed; facial suture within the margin. *O. Desmarestii*, Brongn. *O. Edwardsii*, Rouault.
2. Glabella distinctly lobed; facial suture within the margin. *O. dilatata*, Dalm.
3. Glabella narrow; facial suture on the margin. *O. Buchii*, Brongn. *O. Guettardi*, Brongn.
4. Glabella broad; facial suture marginal. *O. Portlockii*.

There are three or four undescribed British species of *Ogygia*, but at present we know them only by fragments.

J. W. SALTER.

June, 1849.

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* Leonhard and Bronn's "N. Jahrbuch," 1845, translated in Taylor's "Scientific Memoirs," vol. iv.

BRITISH FOSSILS.

DECADE II. PLATE VIII.

CALYMENE TUBERCULOSA.

[Genus CALYMENE. BRONGNIART. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Family Trilobitæ). Axis distinct; glabella lobed, narrower anteriorly; facial suture dividing the posterior head angles, submarginal in front; a rostral shield; eyes supine (with a thin cornea ?); thorax of 13 rings, formed for rolling.]

DIAGNOSIS. *C. lata, depressa, alutacea; margine frontali capitis producto recurvo, genis gibbosis, glabellâ depressâ; thorace axi angusto, pleuris planis usque ad fulcrum, quod ad dimidium anteriùs, ad tertium posteriùs, positum est; caudâ latâ, superne depressâ, lateribus abrupte deflexis; axi conico, subplano,* 7-8 *annulato, costis lateralibus* 5, *planis, sulcis acutis.*

SYNONYMS. *C. Blumenbachii vera? a. tuberculosa,* DALMAN (1828), p. 36? (not tab. 1, f. 2). *C. Blumenb., var. a. tuberculosa.* HISINGER (1837), Lethæa Suecica, 10? (not tab. 1, f. 3). *C. Blumenb.*, MURCHISON, (1839), Sil. Syst., pl. 7, f. 5 only. *C. tuberculosa,* SALTER (June, 1848), " Memoirs of Geol. Survey," vol. ii. part 1, pl. 12.

Almost every author who has written on *Calymene Blumenbachii* has hinted his belief that two or more species were to be recognized among its protean forms; yet, except Colonel Portlock, who separated the *C. brevicapitata* in his report on the fossils of Tyrone, no one has done more than point out varieties. An extended examination of very numerous specimens convinced us that three distinct species were known in England, and their characters were detailed in the 2nd volume of the " Memoirs of the Geological Survey." Still further investigation of intermediate forms has shaken this opinion again, and we are at present wholly in doubt whether the striking differences about to be pointed out mark only a distinct variety, or are of specific value. At all events, in giving a typical species of this genus, we would rather present the reader with a new and well-marked form, than with one so familiar as that of the famous " Dudley fossil."

Description.—Length, about 2½ inches, width, 1½ inch. Whole surface equally and minutely scabrous. General form broad for the genus, not much attenuated posteriorly, depressed. Head short, wide; the glabella not more prominent than the cheeks, and much narrower, contracted in front, and separated by a deep furrow from the front margin: it has three lobes on each side, the basal one large, the middle one nearly spherical, the third minute; the forehead lobe is small, the neck lobe large and prominent. The neck furrow is continued nearly to the posterior angles, which are rounded. Cheeks gibbous, often more elevated than the glabella, bearing the small eyes on their most prominent part. These are placed opposite the middle lobe of the glabella, and at some distance from it. A strong deep furrow separates the cheeks from the glabella, except opposite the eye, where a buttress is thrown across from the cheek, touching the middle glabellar lobe. The wings are strongly bent downwards, and even inwards on the under surface of the head, and the anterior margin is much recurved, and produced into a snout. On looking at the under view of the head, the margin appears greatly bent, and in the angle so formed the curved rostral shield, half as long as broad, is inserted; beneath this is attached the hypostome, which is squarish oblong with the terminal angles rounded, strongly convex forwards, the convexity terminating in a compressed tubercle; one or two concentric lines, as if of growth, mark the surface, which is also scabrous, like the general crust of the body. The axis of the 13 body rings is convex, but narrower than the pleuræ, and constantly tubercular on the sides. The pleuræ are horizontal half way, and then strongly decurved; their ends rounded posteriorly, and bent forward. Fulcrum distant from the axis, about half way from it near the head,—at one-third, or rather less, behind. Pleuræ sharply furrowed, the forward or fulcral half somewhat narrower than the posterior. Tail nearly semicircular, with the front angles truncated, evenly and gently convex, the axis not prominent, the sides decurved strongly towards their edges. Axis not percurrent, narrow, conical, with seven rings, and a terminal boss. Lateral ribs flattened, separated by sharp, narrow furrows, starting at a wide angle from the axis, and curved back on the sides, simple, or but rarely marked by a central line near their ends,—not bifurcate, as in *C. Blumenbachii*.

—— *Junior.*—The proportions of the axis to the sides and the structure of the pleuræ are similar, but the glabella is more cylindrical, not widened below; the tail is proportionally smaller, has the axis wider and more convex, with fewer ribs, and there are but four distinct ribs on each side. Fig. 8* is the tail of a young animal magnified.

Variations.—In some the axis is a little more prominent, in others a greater or less depression of the glabella occurs, and apparently the production forwards of the snout is not always in the same degree. But these variations are within narrow limits, and our species never seems to approach *C. Blumenbachii* in convexity, especially with regard to the glabella and caudal axis. The front is constantly produced, the surface minutely scabrous, not covered with scattered tubercles, but this last character occurs in some varieties of *C. Blumenbachii*, which is more variable than we formerly believed.

Affinities.—It is distinguished from *C. Blumenbachii*, with which it has always been confounded, and to which it is closely allied, by the broad depressed form, narrow axis,* glabella not higher than the cheeks, distant fulcrum, and wide depressed tail; the produced recurved snout also is a strong character. *C. brevicapitata* has the snout recurved, but it is shorter; the axis is prominent, and the fulcrum close to it; the glabella also is much shorter and smaller in front, and the whole form is elongate and cylindrical. With the American species, as published by Green, Hall, and Emmons, it does not need a close comparison: *C. senaria* is attenuated posteriorly, and has a wide head, close fulcrum, and a small tail, with the axis as broad as the sides: *C. callicephala* is distinguished at once by the very short triangular glabella; it has also a close fulcrum. It is quite possible that hereafter forms may be found which will connect this species with the more common *C. Blumenbachii;* but at present we do not know such forms, and it is necessary to point out the obvious characters which distinguish them. Between *C. Blumenbachii*, however, and the other British species, *C. brevicapitata*, specimens intermediate in character, both as regards form and sculpture, have been discovered; the present species, therefore, being founded on somewhat similar kinds of variation, must be received with caution.

History.—The early figures and descriptions of animals of this genus had, of course, no reference to such minute differences as are now deemed necessary for specific character; however, there is one early figure which certainly resembles more the depressed tail of our species, with widely spreading and curved side ribs, than *C. Blumenbachii;* we mean that of Linnæus, "Stockholm Trans.," 1759, t. 1, f. 3.

Dalman describes, under *C. Blumenbachii*, three forms,† viz.:—

1. *Var. tuberculata*, in which he erroneously counts 12 segments to the thorax, and reckons about seven ribs to the tail. Length, 2 inches to 2½. Gottland and England; the English specimen having the axis of the thorax tuberculate on the sides, as in the next variety.

2. *Var. Blumenbachii vera? a. tuberculosa*, with 13 segments, and tail with about eight ribs, the axis tuberculated on its sides; the head, tail, and lateral knobs of the axis closely scabrous; the dorsum (axis itself) smooth. Length about an inch. Gottland.

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* There is a variety of *C. Blumenbachii*, with narrower axis, found at the Hollies, near Horderley, but the glabella and tail are normal, and the front not produced.

† "Et descriptiones auctorum, et specimina ad hac speciem relata, tantas prœbent discrepantias, ut fere credam diversas species sub hoc nomine esse commixtas, de qua re tamen, ob speciminum inopiam, dijudicare nequeo." Dalman, Palæad., p. 35.

3. *Var. Blumenbachii vera, β. pulchella,* " undique punctis elevatis sparsis," the axis hardly tuberculate at the sides; small. Gottland.

Of these three forms the first is the most doubtful. Dalman has probably given a figure of it, bad in all points of detail, in his table 1, fig. 2. This figure seems a little to resemble our species in the rather narrow axis, and distant fulcrum, and there is no indication of bifid ribs to the tail; however, the snout is not produced at all, the axis of the tail is also broad and convex, so that it probably is intended for the common species. Of his var. *pulchella* (tab. 1, fig. 3), we have seen specimens in the cabinet of Sir Roderick I. Murchison. They are dwarfs of *C. Blumenbachii*, and, like it, have scattered tubercles, a large glabella, and convex axis. But the description of var. 2 in so many respects agrees with the subject of our plate, that we have adopted the term *tuberculosa* as a specific name for it. The close minute scabrosity is particularly alluded to by Dalman. Even if the identification be incorrect, it will not involve any confusion of nomenclature. No recognizable figure of this species appeared till the publication of the " Silurian System," in which, at pl. 7, f. 5, a Burrington specimen is figured, and in the description the knots on the axis are mentioned as variable.

British Localities and Geological Position.—WENLOCK SHALE to UPPER LUDLOW ROCKS. Upper Silurian beds, Underbarrow, near Kendal, Westmoreland (Prof. Sedgwick). It abounds in nodules of the Wenlock shale at Burrington, Shropshire, from whence thousands of specimens have been distributed through collections. Small specimens are plentiful at Usk, Monmouthshire, in Upper Ludlow Rock; in neither case associated with the more common *C. Blumenbachii.*

Foreign Distribution.—There is much reason to believe, as before stated, that it occurs with the better known species in Gottland.

EXPLANATION OF PLATE VIII.

Fig. 1. Full-grown specimen from Burrington; the head and tail a little bent down.

Fig. 1*. A specimen from the same locality, partially rolled up, but open sufficiently to show the hypostome or mouth-piece attached to the rostral shield *a*.

Fig. 2. Extended specimen from the same locality.

Fig. 3. Dissected head; *k* is the reflected front.

Fig. 4. Body segment separated, shows the nodular axis, and the distant fulcrum.

Fig. 5. Body segment seen in profile. It shows the depressed form of the body.

Fig. 6. Hypostome highly magnified.

Fig. 7. Magnified portion of the general surface.

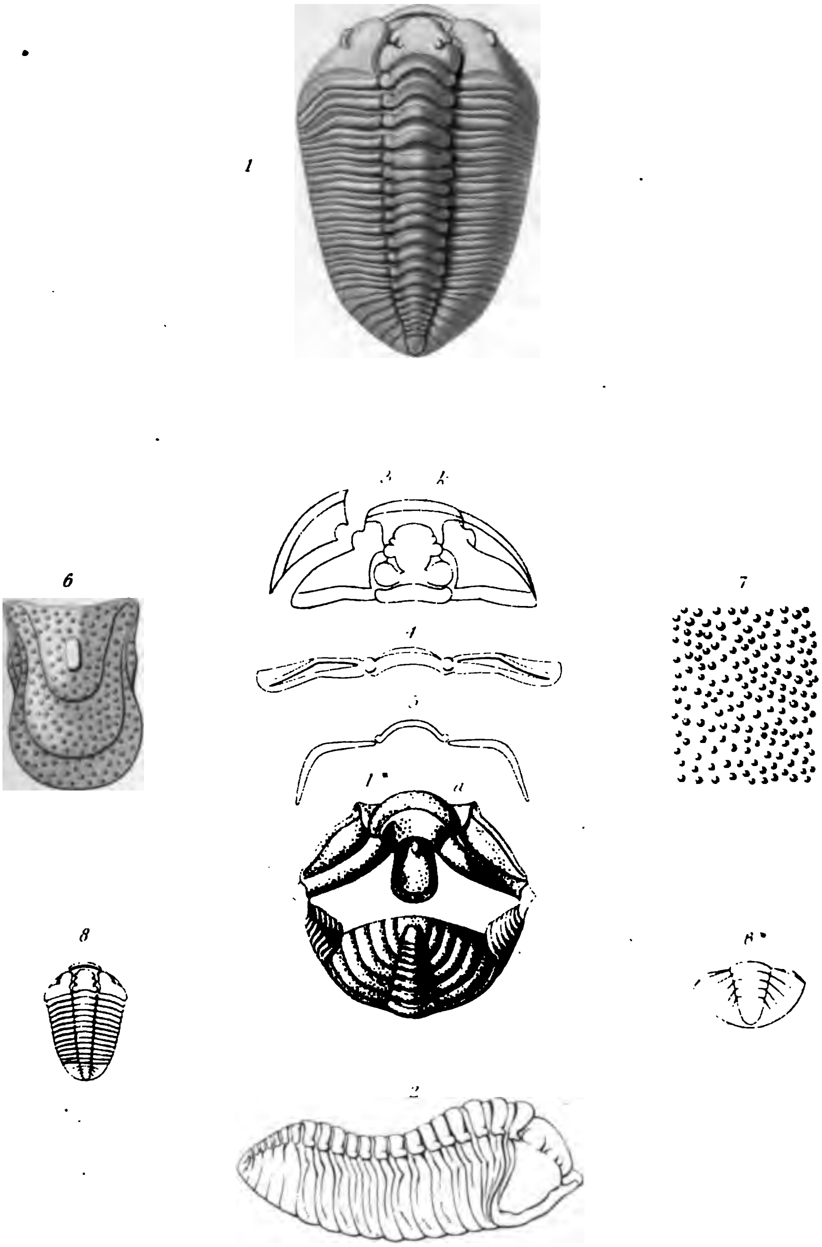
Fig. 8. Young animal from Usk.

Fig. 8 *a*. Tail of ditto magnified.

J. W. SALTER.

June, 1849.

CALYMENE
Silurian.



CALYMENE [illegible] *Salter*

BRITISH FOSSILS.

Decade II. Plate IX.

OLENUS MICRURUS.

[Genus OLENUS. Dalman (in part). Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Family Trilobitæ.) Glabella narrowed anteriorly, lobed; eye smooth, generally with a narrow prominent ridge connecting it with the upper part of the glabella; facial suture marginal in front, and cutting the posterior margin behind; no rostral shield; hypostome . . . . ? pleuræ 14, or fewer, pointed and recurved; tail with articulated axis and sides.]

[Sub-genus *Olenus*. Body rings 14; tail entire.]

Diagnosis. *O. ovatus posteriùs attenuatus; glabellâ genisque æqualibus; thorace segmentis* 14, *pleuris postremis axi angustioribus; caudâ transversâ integrâ, apice truncato, axi* 1-*annulato, lateribus unicostatis.*

In the course of surveying the barren country south of Snowdon, Mr. A. Selwyn, of the Geological Survey, discovered fine specimens of this new *Olenus*. They were found only at two or three localities in the lowest fossiliferous beds of the Silurian system, and may be considered, therefore, as the oldest British trilobites; they were associated with a species of *Eurypterus* and a *Lingula*. The discovery is the more interesting, as *Olenus* and *Paradoxides* are among the most ancient genera of trilobites in the Silurian rocks of the Continent. Other British species of the group have been described by Mr. John Phillips, from the black shales of Malvern.

Description.—Length, one inch three-eighths; width, seven-eighths. General form broadly obovate, acuminate posteriorly; the axis rather prominent, and the sides flattened. Head more than twice as wide as long, semicircular, with a narrow equal border, and produced at the posterior angles into moderate diverging spines. Glabella reaching very nearly to the front margin, bell-shaped, not very convex, but a little swelled below, with a narrow neck lobe, and two lateral lobes. Cheeks a little wider than the glabella. Eyes not large, forward, near the glabella, and connected with it by a slight oblique prominence. Eye line cutting the posterior margin far outwards. Pleuræ 14, flattish, increasing a little in width as far as the 6th segment, then shortened gradually, so that the two last are scarcely wider than the tail; each marked by an oblique shallow furrow, deeper near the tips, which are slightly recurved and produced into short spines. Axis narrowed posteriorly, not so wide as the pleuræ in the anterior rings, but in the hinder ones wider than the pleuræ. Tail semicircular, truncate, the axis convex with one rib above, and about equal in width to the sides, which also have a single faint rib. Margin entire, slightly raised. But four specimens have been found, and all more or less distorted.

Affinities.—From *O. spinulosus*, with which the head has considerable resemblance, the entire truncate one-ribbed tail readily distinguishes it. *O. gibbosus*, besides having a triangular, many-ribbed tail, has the glabella not reaching nearly to the front margin, and the eye is placed at a distance from the glabella nearly equal to the diameter of the latter. In *O. micrurus* it is not above half the diameter distant. *O. alatus*, a small species, named by Dr. Boeck, has the glabella extended forwards, but it is very narrow and convex, and the eye is distant. The *Olenus gibbosus* (Corda), which, in shape of tail, is very different from Swedish specimens and Wahlenberg's description, differs from ours in the wide and ribbed tail, as well as in the general shape, which is oval, not attenuated; besides other points. We know of no other species with which it can be confounded.

British Localities and Geological Position.—LOWEST LLANDEILO FLAGS (Lingula beds), Trawsfynydd, Merionethshire; Cwm-y-Swm mine, Dolgelly, ditto; Marchllyn Mawr, near Llanberis, Caernarvonshire.

EXPLANATION OF PLATE IX.

Fig. 1. *Olenus micrurus*. Trawsfynydd.

Fig. 2. Same dissected. *a*, central lobe of the head,* including *b*, the glabella, and *c*, fixed cheeks; *d*, the mucronate wings; *e*, thorax segments, the obscure fulcral points are at *ff*; tail, *g*, with two-jointed axis, and single lateral furrow.

Fig. 3. Small specimen, Cwm-y-Swm mine, Dolgelly.

Note on the Genus.

The group of *Olenidæ* (Emmerich) includes genera which differ from each other in the course of the facial suture; in *Paradoxides* and *Olenus* its termination is on the posterior margin, and the wings or free cheeks are produced into spines. In *Peltura* (*P. scarabæoides*) and *Triarthrus*, it terminates in the posterior angle, or even a little above it, on the external margin, and the wings are very small, and by no means produced into spines.

Paradoxides differs from *Olenus* in the large and clavate, not bell-shaped, glabella; in possessing 16 to 20 body rings, and a minute tail, with its axis only articulate.

Olenus is divisible into two sections, if these do not merit the name of genera. 1. The group of true *Olenus*, to which our species belongs, having 14 body rings, and a tail with entire margin. 2. *O. spinulosus*, having fewer, about 12 body rings, and a spinose or laciniate tail; for the latter species, the sub-generic name *Parabolina*, in allusion to the shape of the glabella, might be appropriate.

June, 1849. J. W. SALTER.

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* Corda has proposed to call all this "glabella," and to distinguish it into central and lateral lobes.

Geological Survey of the United Kingdom.

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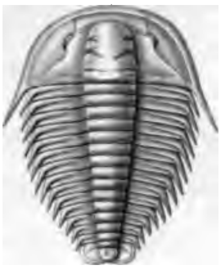

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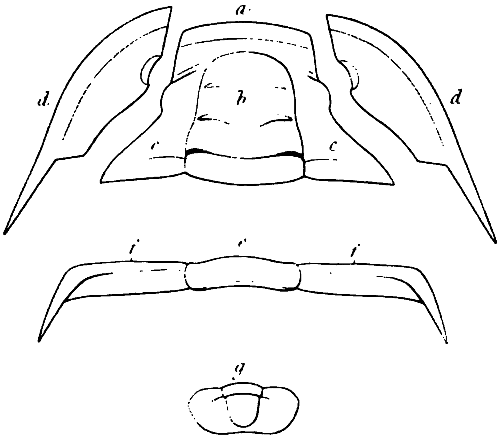


3

OLENUS MICRURUS *Salter.*

[illegible] [illegible]

BRITISH FOSSILS.

DECADE II. PLATE X.

AMPYX NUDUS.

[Genus AMPYX. DALMAN. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Family Trilobitæ.) Glabella tumid, armed with a frontal spine; head with simple, unexpanded margins; angles spinous; no facial suture; no eyes; body rings 5 or 6; tail entire-margined, margin deflected; hypostome ?]

DIAGNOSIS. ***A. latus; capite semicirculari, spina frontali brevi; angulis longe-spinosis; glabella vix producta, lateribus bilobatis; thorace articulis* 6*; caudâ lateribus* 8—9 *sulcatis.***

SYNONYMS. ***Trinucleus nudus*, MURCHISON (1839), "Sil. Syst.," p. 660, pl. 23, f. 5.**

Description.—General outline broadly oval; body much depressed; the general axis, consisting of glabella, axis of thorax, and axis of tail, forming a lanceolate, convex, central elevation, narrowing posteriorly. Head, thorax, and tail of equal length. The first is rounded, with the outline, in front, slightly prominent, and the whole less than a semicircle; the last is slightly triangular. Glabella somewhat claviform, rounded and convex in front, narrowing behind the middle, and slightly widening out at its junction with the neck furrow; it is marked at each side by two or three indistinct furrows, and, towards its centre, by two very oblique furrows, which form small elliptical elevated spaces, one on each side, bounded by rounded and curved folds, below the level of the rest of the glabella, and appearing as if distinct from it. From the front of the glabella projects a slender subulate spine, which, in all examples hitherto met with, is rather less than the length of the head: it is not continued as a keel on the central surface of the glabella. The neck furrow is well marked, and the neck fold elevated. The cheeks are broad, depressed obliquely in their centres; the depression proceeds from near the upper extremity of the glabella lobes, and continues obliquely outwards, with an obscure curve towards, but not touching the margin. Between the depression and the hinder portion of the glabella the cheek is gently tumid, and likewise between the depression and the outer margin. The neck furrow runs straight and

EXPLANATION OF PLATE X.

Fig. 1. Figure of the entire trilobite, slightly restored, from the Builth specimen. All the parts are shown in specimens in the collection of the Geological Survey.

Fig. 1*. Dissection of the species. Lines as if of a facial suture are seen on the glabella, but they do not seem to indicate any true separation of parts.

Fig. 2. An individual still younger.

Fig. 3. A small specimen, showing the constancy of its characters at an early stage.

Fig. 4. Granulation of the head.

Fig. 5. Granulation as seen towards the extremity of one of the pleuræ.

Fig. 6. Lineation of deflected surface of tail margin.

Note on the British Species of Ampyx.

The genus *Ampyx* was first recognized as British by Lieut.-Colonel Portlock, R.E., who described and figured two species, *Ampyx Austinii*, identical with *A. mammillatus* (Sars), and *Ampyx Sarsii*, identical with *A. rostratus* (Sars), and probably with *A. nasutus* (Dalman). Both these forms were discovered during the researches of the Ordnance Geological Survey in Ireland, the former in the Silurian slates of Tyrone, and the latter in those of Newtown, near Waterford. Recent researches have led to the conclusion that the strata in which these fossils were found are members of the lower (Llandeilo or Bala) division of the Silurian rocks.

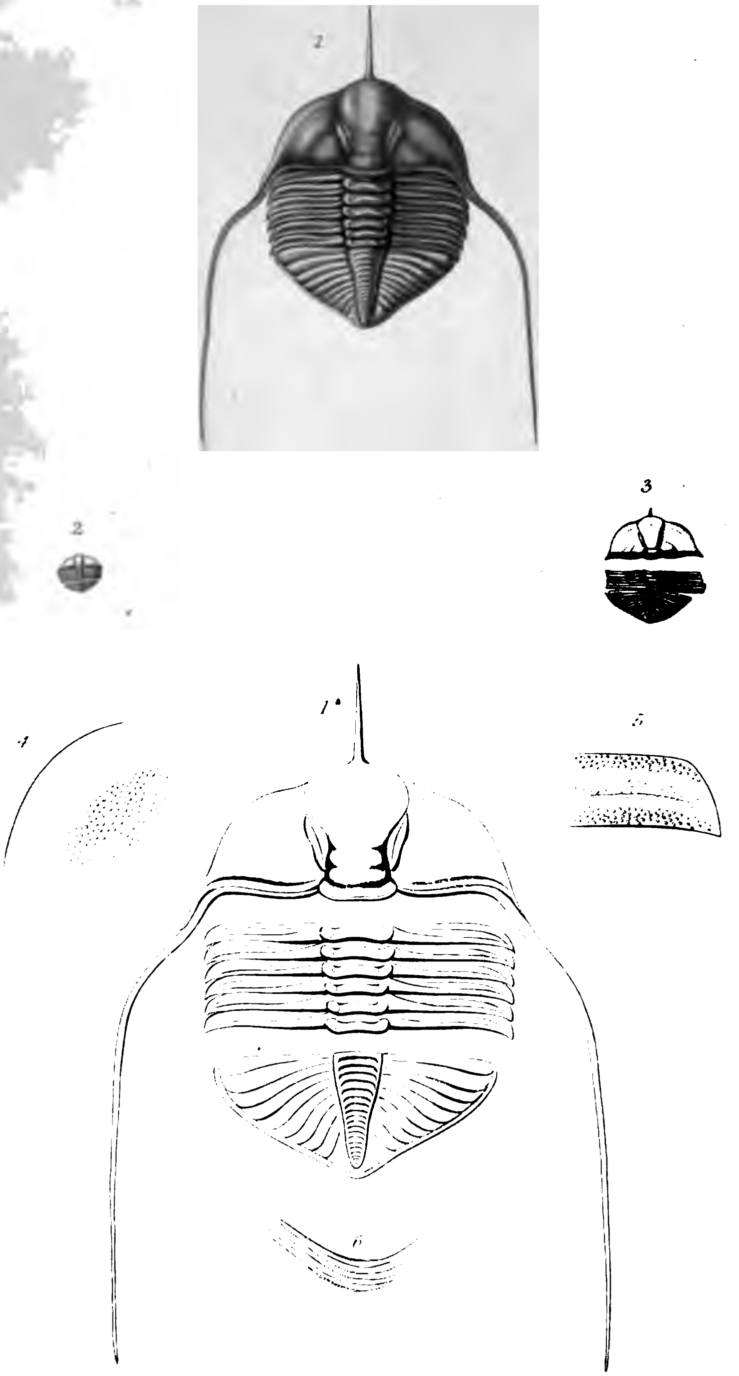
In Great Britain neither of these species of *Ampyx* have, as yet, occurred. The only species described as British, besides that now figured, is my *Ampyx parvulus*, from the Lower Ludlow of Vennal Hill (Mem. Geol. Surv., vol. ii. pt. 2, p. 350, pl. x.) There appears, however, to exist a third species in the Rhiwlas limestone, near Bala; one distinct from any as yet described, but of which only heads and tails have been found. The largest head is half an inch in length, exclusive of the spine. It is nearly allied to *A. rostratus*, but differs in having much smaller cheeks in proportion to the glabella, which is even more produced than in the *rostratus*, and exceedingly tumid. The cheeks in the species to which I have compared it are beyond the middle of the glabella; in the Rhiwlas form never so far as that part. The neck lobe of the latter is narrow, and the tail, though similar in sculpture, much shorter and wider. The proportions of the cheeks and glabella remind us of *A. Bruckneri* (Boll in Dunker and Von Meyer's Palæontographica, 1st Band, 11 lief., t. xvii., f. 8), but that species has a carinated glabella, and very broad neck lobe. *Ampyx Portlockii* (Barrande), is said to have the glabella much less elongated than *A. nasutus*, and therefore cannot be the Rhiwlas form. *A. bohemicus* (Hawle and Corda, t. 3, f. 19), comes nearer, but is represented as having a much wider glabella and a proportionately much smaller tail, with no traces of rings on its axis. I propose to name the Rhiwlas species, *Ampyx tumidus*.

Ampyx baccatus, of Portlock, does not belong to this genus.

E. FORBES.

July, 1849.

Geological Survey of the United Kingdom.



AMPYX NUDUS *Murchison*

F. Forbes del.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE III.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

LONDON:
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NOTICE.

Palæontological researches forming so essential a part of geological investigations, such as those now in progress by the Geological Survey of the United Kingdom, the accompanying plates and descriptions of British Fossils have been prepared as part of the Geological Memoirs. They constitute a needful portion of the publications of the Geological Survey, and are taken from specimens in the public collections, or lent to the Survey by those anxious to advance this branch of the public service.

The plan proposed to be followed in the work, of which this Decade forms a part, is as follows:—

To figure in elaborate detail, as completely as possible, a selection of fossils, illustrative of the genera and more remarkable species of all classes of animals and plants the remains of which are contained in British rocks; to select especially such as require an amount of illustration which, to be carried out by private enterprise, would require a large outlay of money, with little prospect of a return, and a long time to accomplish, but which, by means of the staff and appliances necessarily employed on the Geological Survey, can be effected at small cost, and with a rapidity demanded by the publication of the Maps and Memoirs of the Survey; thus, it is hoped, affording an aid to those engaged in the sciences with which this work is connected, that they might not otherwise have possessed, and which may materially promote the progress of individual research.

H. T. De la Beche,
Director-General.

Geological Survey Office, Jermyn Street,
30th June, 1850.

BRITISH FOSSILS.

DECADE THE THIRD.

The third Decade of representations of British Fossils follows up the subject of the first, and continues the series of illustrations of the genera and species of extinct Echinodermata, especially those belonging to the orders *Asteriadæ* and *Echinidæ*.

The genera illustrated in this Decade are partly new, partly long-established; so also with the species, some of the most remarkable of unpublished forms having been selected, as well as some of the commonest and best known fossils. Yet, even respecting those which are so familiar that their whole history is believed to have been long ago made out, there is so much to be cleared up, so many points of structure hitherto very imperfectly or not at all elucidated, and such an accumulation of synonyms, that their investigation is much more laborious, and occupies much longer time, than inquiries into entirely new types. Thus, three of the fossils figured and described in this Decade, *Hemicidaris intermedia*, *Galerites albogalerus*, and *Micraster cor-anguinum*, are so familiar to geologists and naturalists, so abundant and so well preserved, that authors do not hesitate to cite them without comment, as if they were free from any obscurity. Nevertheless, I may say confidently, that not until now has the literature of these well-known and often-described forms been cleared up, and many of the most important points in their organization made known. Common as they are, no representations of them, presenting sufficient details of their structure, have ever appeared before.

Among the new forms now first described and figured, some are of singular interest. Two of them, the *Lepidaster Grayii* and the *Tropidaster pectinatus*, are not only new as species, but unquestionably possess features entitling them to become the types of new genera. Of those belonging to old genera, the *Uraster Gaveyi* is singularly interesting, presenting, as it does, the spectacle of a Liassic echinoderm, which so closely resembles the commonest star-fish now living in the British seas, that it can only be distinguished from it by a minute and critical comparison; and the *Hemicidaris Purbeckensis* is remarkable as being the first member of its tribe ever discovered in strata of the Purbeck series.

The species described and figured have been selected from formations of different geological epochs. From Silurian rocks *Lepidaster Grayii* has been taken; from older secondary strata, the two forms of *Hemicidaris*, the *Galerites* (*Holectypus*) *hemisphærica*, chosen on account of its being new to Britain, and also affording an excellent illustration of the sub-genus to which it belongs, and the *Dysaster ringens*, selected for the same reasons; also the new star-fishes, species of *Uraster* and *Tropidaster*, already alluded to. Of cretaceous fossils there are the critical *Galerites castaneus*, and the characteristic *Galerites albogalerus* and *Micraster cor-anguinum*.

A third series of illustrations of the fossil Echinoderms is far advanced, and in preparation for publication.

EDWARD FORBES.

June, 1850.

BRITISH FOSSILS.

DECADE III. PLATE I.

LEPIDASTER GRAYI.

[Genus LEPIDASTER (λεπις, a scale, and αστηρ, a star.) FORBES (1850). (Sub-kingdom Radiata. Class Echinodermata. Order Asteriadæ. Family . . . .?) Body depressed, stellate, many-rayed; rays short, tapering, covered above with polygonal ossicles; below formed of four series of oblong squamose ossicles.]

SPECIES UNICA. *Lepidaster Grayi.*

The unique and very remarkable fossil figured in the accompanying plate has been communicated by Mr. John Gray of Dudley, a gentleman to whom palæontological science is indebted for numerous and important discoveries among Silurian fossils, and whose splendid collection has been most liberally placed at the service of all engaged in scientific researches.

At first glance it bears a striking likeness to a star-fish of the genus *Solaster*; its general form recalling strongly the aspect of *Solaster papposa.* On a closer inspection the resemblance proves more apparent than real, and no near affinity with that genus can be proved. On the contrary, it not only possesses characters so peculiar as to establish beyond question its right to rank as a separate generic type, but even to render doubtful its position among true star-fishes, and to raise the question whether it be not a linking form connecting that order of Echinoderms with the Crinoids.

The disk of our fossil is a very little more than two inches in diameter. It is, unfortunately, so injured that its elements cannot be clearly made out, but appears to have had a framework composed of closely-set polygonal ossicula. Around it are arranged the rays, equidistant from each other, like so many spokes of a wheel. Their average length is one inch and one-twelfth, and their breadth towards the base four-twelfths. They are all regularly lanceolate. Their under surfaces are exposed on the slab, and are composed of thick transversely oblong plates, slightly overlapping each other in scale-like fashion, and ranged in four longitudinal rows, two on each side of a central or ambulacral groove, which is itself, towards the extremity, in some instances partially filled up by small polygonal intervening plates. Of the two rows of border plates on each side of the groove, the inner series is formed of oblong obscurely hexagonal ones, with traces of punctations and grooves on their surfaces, as if for spines. The ray that is most perfect exhibits twenty-five plates in each row. The outer series consists of suborbicular or obscurely polygonal plates, which, like the inner ones, are gently convex on their surfaces. The upper surface of the ray, and probably of the body, was composed of numerous small polygonal nearly flat ossicula, closely set, and of various sizes.

Mr. Gray has dissected from the slab the extremity of one of the rays in such a manner as to permit an examination of both upper and under surfaces of the same ray: the result of an examination of the fragment detached confirmed the above description.

Locality and Geological Position.—This star-fish was found in the quarries of WENLOCK LIMESTONE in the Castle Hill, at Dudley. At the same time, a number of encrinite remains of several species, both perfect specimens and fragments, were found associated with it. Mr. Gray states, that after a careful search not even a fragment of another specimen of this exceedingly curious fossil has been detected.

EXPLANATION OF THE PLATE.

Fig. 1. The entire specimen of *Lepidaster Grayi*; its under surface is exposed on the slab.

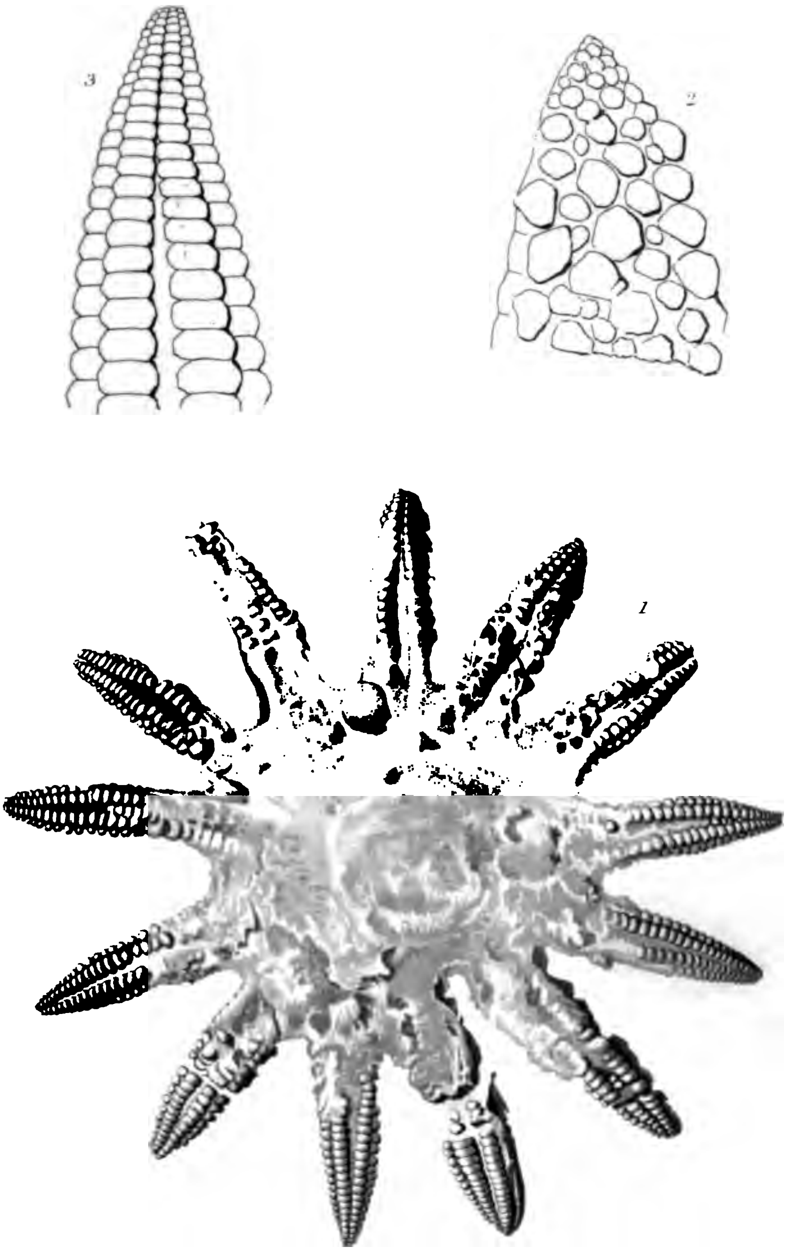
Fig. 2. Upper surface of the extremity of a ray; greatly enlarged.

Fig. 3. Under surface of the same ray.

EDWARD FORBES.

June, 1850.

LEPIDASTE
(Silurian)



LEPIDASTER GRAYI *Forbes.*

BRITISH FOSSILS.

DECADE III. PLATE II.

URASTER GAVEYI.

[Genus URASTER. AGASSIZ. (Sub-kingdom Radiata. Class Echinodermata. Order Asteriadæ. Family Urasteriæ.) Body stellate, five-rayed; a vent on the dorsal surface; rays rounded, surface spinous; ossicula small, compressed, irregular, reticularly combined; ambulacra bordered by three sets of spines; suckers quadriserial. The genera ASTERACANTHION of MÜLLER and TROSCHEL, and ASTERIAS (restricted) of J. E. GRAY, are synonymous with URASTER.]

DIAGNOSIS. *U. brachiis quinis, lanceolatis; paginâ superiori valde spinosâ, spinis brevibus, teretibus; ossiculis ambulacralibus linearibus, arcuatis, carinatis, carinâ extus sulcatâ intus fossatâ.*

Description.—This remarkable star-fish is of the shape and dimensions of the common living *Uraster rubens*, to which it presents also a striking resemblance in the details of its structure. Indeed, were this lias fossil to be resuscitated and cast upon our shores now, the British naturalist would see in it only a new but by no means surprising form of *Uraster*, having close affinities with, and requiring to be distinguished by critical characters from, the commonest of our native *Asteriadæ*.

The under surface of the specimen is the one exposed, but sufficient of the upper side is exhibited at the sides of the arms to show its structure and armature. The whole of the upper surface of the rays and disk appears to have been covered with thickly-set, rather short, tapering spines, mingled with smaller and slenderer ones, and traces of *pedicellariæ*. The ambulacra are bordered by closely-set narrow plates with steep inner sides, and having their upper surfaces convexly curved and indented by about five depressions, indicating the sockets of as many rather short, slender, and rounded marginal spines. The ambulacra themselves are rather wide and flattened; down the centre of each is a shallow grove marking the line of junction of the ambulacral ossicula. These are very narrow and linear in shape, slightly bent, with the appearance of a very shallow sigmoid curve. This is caused by the curved keel which runs down each, grooved throughout two-thirds of its length, but depressed and marked with two pit-like impressions in the neighbourhood of the ambulacral sulcus; the ends of the ossicula which go to form the sulcus are slightly denticulated. The curvation of the ossicula has reference to the disposition of the suckers, which in this genus are arranged in four series down each avenue. The perforations are slightly ovate in this species.

Dimensions.

	Inches.
Breadth of disk	$1\frac{2}{12}$
Maximum breadth of a ray	$0\frac{8}{12}$
Maximum breadth of an ambulacrum	$0\frac{6}{12}$
Length of a ray from angle of junction with the body	$3\frac{1}{12}$
Length of an ambulacrum from its origin at the mouth . . .	4

Affinities.—This species, as I have already indicated, approaches more nearly to the existing *Uraster rubens* and its allies than to any described secondary or palæozoic fossil. The *Asterias lumbricalis* and the *Asterias lanceolata* of Goldfuss, both from the jurassic beds in Germany, have been referred by me to the genus *Uraster*,* but they are imperfect forms at best, and possibly, when found in more complete condition, may prove to belong to other generic types. Not so with the star-fish now described; there can be no mistake about its generic position and affinities, as the most essential part of its osseous framework, the ambulacral skeleton, is perfectly preserved.

Locality and Geological Position.—The only specimen hitherto found of this singular and beautiful fossil occurred in the LIAS beds laid open during the excavation of Mickleton Tunnel, in Gloucestershire. It was discovered by Mr. G. E. Gavey, civil engineer, of Chipping Campden, Gloucestershire, who most liberally communicated it for description and delineation to the Geological Survey. It lies on the surface of a sandstone associated with fragments of Pentacrinites, small Ammonites, Aviculæ, and small univalves.

DESCRIPTION OF THE PLATE.

Fig. 1. The fossil, natural size.
Fig. 2. Plan of the ambulacral plates and their spiny borders.
Fig. 3. Diagram of the same parts in the living *Uraster rubens*, introduced for comparison.

EDWARD FORBES.

June, 1850.

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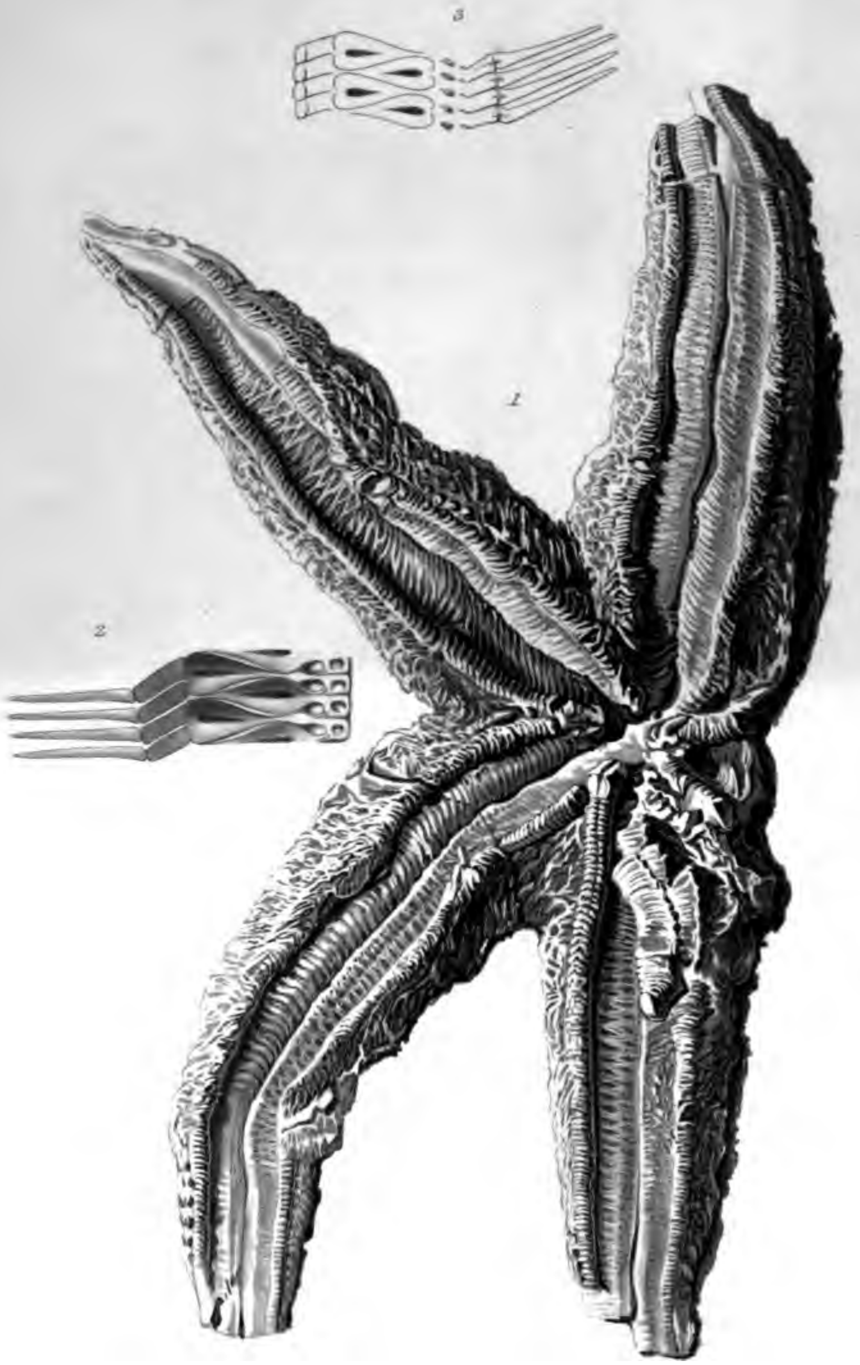
* See "Table of Fossil Asteriadæ" in vol. ii. pt. 2, p. 481, of the "Memoirs of the Geological Survey of Great Britain."

URAST
(Oolitic)



URASTER GAVEYI. *Forbes*

BRITISH FOSSILS.

DECADE III. PLATE III.

TROPIDASTER PECTINATUS.

[Genus TROPIDASTER (new.) FORBES (1850.) (τρωπις, a keel, and αστηρ, a star.) (Sub-kingdom Radiata. Class Echinodermata. Order Asteriadæ. Family Asteriæ.) Body stellate, five-rayed [a vent on the dorsal surface?]; rays convex and carinated above, the carina composed of a double series of squamose plates; rest of the dorsal surface spinous, spines simple; ambulacra bordered by transverse plates with spiniferous crests on their anterior margins; ambulacral ossicula rather broad, geniculated, pectinated at their inner extremities. (Suckers biserial.)]

SPECIES UNICA. *Tropidaster pectinatus.*

Description.—The general aspect of this star-fish when seen from above is that of a *Uraster*, whilst viewed from below it resembles an *Astropecten*. The rays are rather short, about equal in length to the breadth of the disk, ovato-triangular. The upper surface of the rays and disk is covered with short obtuse simple spines, which, on the sides of the rays, are ranged in oblique rows of about five or six in each row. Placed rather laterally on the disc is seen, though obscurely, a madreporiform plate, and I think I can perceive indications of an anal pore. Down the centre of each ray runs a keel composed of two rows of squamous plates, somewhat quadrate in form, but produced at their anterior and inner angles. This kind of keel, or mid-rib, is not present in any star-fish, recent or fossil, with which I am acquainted, and resembles in form and structure the tiling of the crest of the roof of a house. It must be regarded as a peculiarity of generic value. The rays themselves appear to have been very flexible, and not much liable to injury. Their extremities are rather pointed. On the under surface their centres are occupied by the rather broad lanceolate ambulacral grooves running from the mouth; that orifice is somewhat contracted by the encroachment of the large twin triangular plates with punctated surfaces which occupy the angles formed by the junction of the bases of the rays. The ambulacral ossicula are oblong, rather broad, strongly geniculated in the centre at their anterior margins, and denticulated by about five crenations at the edge which borders the ambulacral sulcus. The margins of the under surfaces of the rays are bordered by transverse, oblong, rather narrow plates, each bearing a crest at its anterior border indented by the sockets of eight or more rather short cylindrical spines, which have rugose surfaces. It is these crested marginal plates with their rows of spines which give the under surface so much of the aspect of an *Astropecten*.

Dimensions of the largest Specimens.

	Inches.
Diameter from apex of one ray to that of the one most distant . . .	$1\frac{8}{12}$
Breadth of disk	$0\frac{9}{12}$
Breadth of a ray at origin	$0\frac{4}{12}$
Length of a ray from angle of junction	$0\frac{1}{2}$
Breadth of largest inferior marginal plate	$0\frac{3}{12}$
Length of marginal spine, rather more than	$0\frac{1}{12}$

Locality and Geological Position.—This remarkable star-fish was discovered by Mr. John Gavey, civil engineer, of Chipping Campden, in the LIAS of Mickleton Tunnel, Gloucestershire. Several specimens occurred, and some fine examples, presented by that gentleman, are displayed in the cabinets of the Museum of Practical Geology.

DESCRIPTION OF THE PLATE.

Fig. 1. Large specimen; ventral surface displayed.

Figs. 2 and 3. Dorsal surfaces of two smaller examples.

Fig. 4. Dorsal surface of a ray and part of disk, showing the keel-plates and their arrangement.

Fig. 5. Ventral surface of a ray and part of disk showing the ambulacra and angle-plates.

Fig. 6. Ambulacral plates and spiniferous plates bordering the ambulacra.

Fig. 7. Margin plates.

Fig. 8. Madreporiform plate.

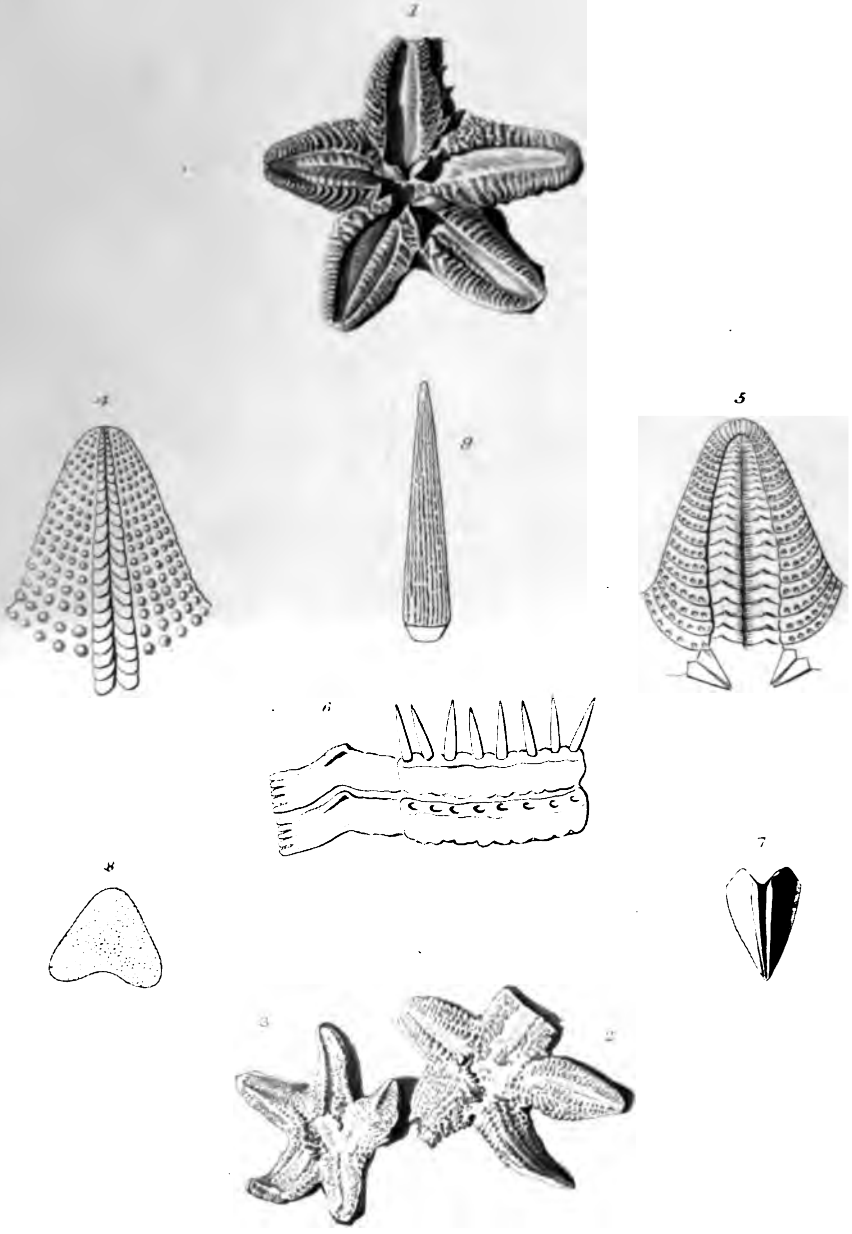
Fig. 9. A spine.

Figs. 4 to 9 are highly magnified.

EDWARD FORBES.

June, 1850.

TROPIDASTER
(Oolitic)



TROPIDASTER PECTINATUS . . *Forbes*

BRITISH FOSSILS.

DECADE III. PLATE IV.

HEMICIDARIS INTERMEDIA.

[Genus HEMICIDARIS. AGASSIZ. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cidarites.) Body sub-globose; interambulacral segments very broad, bearing (few) primary perforated tubercles placed on crenated mammillary elevations; ambulacral areas very narrow, furnished with primary tubercles on their lower portions; pores in single file, except close to the mouth, where they are ranged in threes; summit crowned with a disk composed of five ovarian and five ocular plates surrounding a central anus; spines of two orders, the primaries long, cylindrical, mostly of considerable dimensions, the secondaries small, compressed.]

DIAGNOSIS. ***H. testâ subglobosâ, areis ambulacralibus infra tuberculis majoribus confertis, interambulacralibus tuberculis approximatis; spinis subteretibus, cylindricis, longitudinaliter striatis, striis minutis, basi tumido.***

SYNONYMS. **Variation of *Cidaris papillata*, PARKINSON, Organic Remains, vol. iii., p. 14, pl. 1, fig. 6; and pl. 4, fig. 20. *Cidaris intermedia*, FLEMING, Brit. Animals, p. 478 (1828). *Hemicidaris crenularis*, MORRIS, Cat. of Brit. Fossils, p. 53 (1843).—BUCKMAN and STRICKLAND'S Edition of Murchison's Geology of Cheltenham, pl. 13 (1845).**

The most common example of the genus *Hemicidaris* in British collections, is the species before us; the abundance and perfection of specimens rendering it a favourite fossil. It is usually regarded as the *Cidaris crenularis* of Lamarck, and is cited under that name in memoirs and works on English geology. For the following reasons, however, I feel obliged to reject the appellation of *crenularis* as applied to the English species, and to omit the usual citations and references to Lamarck and older authors, and to Goldfuss, Desmoulins, Agassiz, and Desor.

In the "Description des Echinodermes Fossiles de la Suisse," Agassiz has described at length and figured the *Hemicidaris crenularis* of Switzerland as the species of Lamarck and other authors. He has presented a specimen in remarkably perfect condition, its spines being entire. The figures are excellent, but the species, as the spines plainly show, is not the so-called *crenularis* of British geologists. As the bodies of the two species can only be critically distinguished from each other—unfortunately a frequent case in this genus—it is difficult to know to which the figures of Goldfuss, and the imperfect older representations of Bourguet and Knorr should be referred. But the figure in Parkinson's "Organic Remains" (Pl. XLIII., fig. 6) of a "mammillated echinite from Wiltshire," unquestionably represents the species under consideration, though usually quoted as identical with the *crenularis* of Agassiz. The figure in Pl. IV., fig. 20, of the same work, representing a Wiltshire fossil with its spines, seems to me to belong to this species also, though it does not appear to have been cited as such except by Phillips in his "Geology of Yorkshire." In Dr. Fleming's "History of British Animals," the name *Cidaris intermedia* is applied to the former figure. Now as Lamarck expressly mentions that his *Cidaris crenularis* came from Switzerland, and as the *Hemicidaris crenularis* of Agassiz may fairly be regarded as that species, whilst it has been fully described and figured, and is certainly distinct from the British one, I propose to use Fleming's name of *intermedia* for the latter, and leave *crenularis* to that of Agassiz; thereby confusion will be avoided in future. Dr. Mantell has copied the figure of the Swiss species in his "Medals of Creation," vol. i. p. 340, remarking, however, that though usually identified with Parkinson's, he had never seen specimens in the English oolite like that figured by Agassiz.

Hemicidaris crenularis is sub-globose, varying from a depressed spheroid to a barrel-like shape. Its surface is elegantly studded with very prominent and large bosses bearing on their crenulated summits the perforate spiniferous tubercles. The ambulacral areas are very narrow at their summits, but gradually widen out in their course downwards, and immediately at the margin of the mouth are equal in diameter to the buccal ends of the interambulacral spaces. The latter are widest in their centres, and gradually narrow towards each end. Each interambulacral area is occupied by two rows of tubercles, each row including from six to eight, and as there is one of these tubercles on each interambulacral plate, the total number of plates in each area is from twelve to sixteen. Each plate is mainly occupied by the boss and its areola, the latter being quite smooth, and occupying less than half of the width of the former, which is also smooth, distinctly separated from the areola, very prominent, and depressed on its summit, where it is strongly crenulated around the base of the spheroidal deeply-perforated spiniferous tubercle. The tubercle is in diameter rather more than the breadth of the areola. The areolated spaces of the several plates are confluent; consequently on the upper and lower edges of the interambulacral plates there are no granules. But along the edges of both sides of each plate, there is a conspicuous row of small but well-marked perforated secondary tubercles, partially separated from each other by one or two granules. There are seven or eight of these on each edge of the larger plates. This produces the effect of a sinuous elevated space ornamented with a double row of granules (secondary tubercles) running down the centre of each interambulacral area, and a similar single row separating the ambulacral area on each side from the poriferous avenues. The ambulacral areas bear very small spiniferous tubercles compared to those on the interambulacrals. On their upper and middle portion the tubercles are very small, but just below the largest interambulacral plate increase suddenly, then gradually diminish as they approach the mouth. There are about seven in a row (or fourteen in each ambulacral area) of the larger tubercles, of which, however, those nearest the mouth are as small as the ambulacral tubercles of the upper and middle portions of the area. Like the large primary bosses of the interambulacral plates, those of the ambulacrals also are crenulated at their summits below the perforated tubercles which crown them. The lower and larger ones are separated from each other by a few occasional granules, the upper ones are more distinctly bordered by minute granules. As there is only one spiniferous tubercle to each ambulacral plate, the effect of the ambulacral area is that of a widening space studded by closely-set tubercles, ranged in two rows, and suddenly increasing in size at the lower margin of the sides of the test. The avenues of pores are slightly sinuous; the pairs of pores are ranged in single file as far as just below the sudden increase in the size of the ambulacral tubercles, when they become irregular and arranged in oblique rows of three pair in each. There are five or six of such rows extending to the mouth and causing the avenues to widen out considerably in the buccal region. There are nine or ten pair of pores opposite each of the larger plates.

The mouth is very wide, occupying three-fifths of the under-surface; its margin is deeply notched and reflexed at the junction between each interambulacral series of plates and the poriferous avenues. There results a division of the mouth-margin into ten segments, five (those opposite the ambulacral spaces) wider than the other five.

The genital disk occupies a fourth of the diameter of the test. It is pentagonal, composed of five genital and five ocular plates. Three of the former are larger than the other two; one of the three is the madreporiform plate. There is not so great a disparity in the dimensions of the ocular plates. The effect of this arrangement is to cause an eccentricity of the anal perforation. Both genital and ocular plates are irregularly studded with numerous small granules. The genital pores are placed in the lower portions of their plates. The eye-holes are very minute, marginal, and opposite the truncated ends of the ambulacral spaces.

The primary spines are long, tapering, and nearly cylindrical; the larger ones grow to a length more than twice that of the diameter of the body. They are minutely and closely striated throughout their length, but the striæ are rather broader than the raised interstices. The base of each spine has a narrow elevated fold surrounding it above its ring of crenulations, which are numerous, oblong, and closely and regularly set. The secondary spines (those surrounding the primaries on the interambulacral areas and entirely occupying the ambulacral spaces) are very small, compressed, rather spatulate and longitudinally striated. One of the largest measured two-tenths of an inch in length. I have seen traces of pedicellariæ, but not sufficiently perfect for description.

Locality and Geological Position.—This species is very abundant, and found in a beautiful state of preservation in the CORAL RAG of Calne. It is scarcer near Weymouth. It occurs also in the same stratum at Malton, and is recorded from the Coral Rag of Yorkshire by Professor Phillips. Mr. Buckman has figured a remarkably fine specimen from the neighbourhood of Cheltenham. In consequence of the doubts hanging over the identification of the British with the foreign *Hemicidaris crenularis*, I do not venture to give its foreign distribution.

EXPLANATION OF THE PLATE.

Fig. 1. Middle-sized specimen of the sub-depressed form of *Hemicidaris intermedia* seen in profile; an outline of the tall variety, from a specimen in the British Museum, is drawn around it.

Fig. 2. Dorsal surface; and Fig. 3, ventral surface of the same specimen.

Fig. 4. Ambulacral and interambulacral plates and their sculpture, taken from the centre of the sides.

Fig. 5. Ambulacral and interambulacral plates of the neighbourhood of the mouth.

Fig. 6. A single primary tubercle.

Fig. 7. Genital and ocular disk.

Fig. 8. Spines from a specimen presented to the Geological Survey by Mr. Clark of Sandgate.

Fig. 9. Base of a primary spine magnified.

Figs. 10 and 11. Small secondary spines.

Figs. 4—7 and 9—11 are magnified.

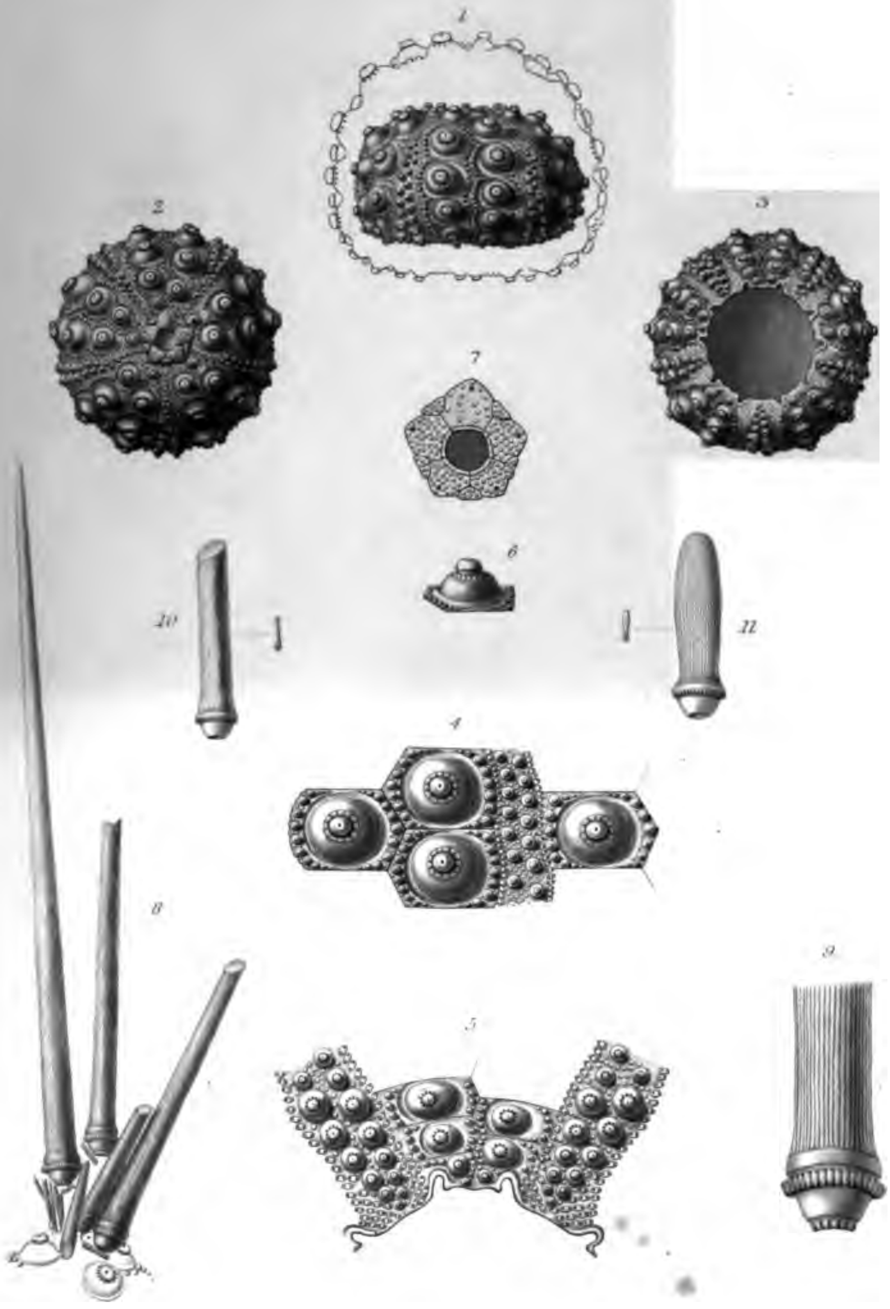
EDWARD FORBES.

June, 1850.

DECADE 3. PL. 4

Geological Survey of the United Kingdom.

HEMICIDARIS
(Oolitic)



HEMICIDARIS INTERMEDIA.—*Fleming*

BRITISH FOSSILS.

DECADE III. PLATE V.

HEMICIDARIS PURBECKENSIS.

[Genus HEMICIDARIS. AGASSIZ. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cidarites.) Body sub-globose. Interambulacral segments very broad, bearing (few) primary perforated tubercles, placed on crenated mammillary elevations; ambulacral areas very narrow, furnished with primary tubercles on their lower portions; pores in single file, except close to the mouth, where they are ranged in threes; summit crowned with a disk composed of five ovarian and five ocular plates surrounding a central anus; spines of two orders, the primaries long, cylindrical, mostly of considerable dimensions, the secondaries small, compressed.

Hemicidaris Purbeckensis. **Sp. Nov.**

DIAGNOSIS. ***H. testâ subglobosâ, arearum ambulacralium infra tuberculis majoribus remotis; interambulacralium numerosis* (8), *subdistantibus; spinis sub-compressis, lævibus, ad basin per spatium angustum striatis.***

The species of *Hemicidaris* are difficult to distinguish from each other, unless we have their spines as well as test before us. Fortunately, in the present instance, we have both; although the specimen figured is unique. The body at first glance might be confounded with that of *Hemicidaris intermedia*, but on closer examination presents distinctive characters, the value of which is confirmed when we see the wholly different features of the spines.

The body is sub-globose, depressed above, but probably, like its congeners, liable to variation in this respect. The interambulacral areas are, about the centre of the sides, rather more than three and a-half times the width of the ambulacral spaces in the same region. On each interambulacral plate there is a primary tubercle, erected on the crenated summit of an elevated smooth boss, surrounded by a smooth and defined areola. The ambulacral and centro-sutural sides of this areola are marginated by rather scattered rounded granules, but not the upper and lower margins, where the areolæ of contiguous plates may be said to be in contact. The areola is wide in comparison with the boss. There are about eight primary tubercles in each row, gradually increasing in size as they approach the centre of the sides of the body. The ambulacral spaces bear in their upper portion, and for two-thirds of their length, small secondary perforated tubercles on minute bosses, one to each plate, with scattered granules between them. On the lower third of the ambulacral areas these suddenly increase in size to twice the dimensions of those above. The large ambulacral tubercles are diffusely arranged, so as to alternate with considerable interspaces. The avenues of pores are slightly undulating. About nine pores correspond to an interambulacral central plate. The mouth in our only specimen is concealed, and the apical disk not preserved.

The spines are quite smooth, slender, and subcylindrical, slightly compressed at the sides. There is a short longitudinally striated well defined space above the swollen crenated neck. The articulating base is small.

The diameter of the specimen is one inch and two-twelfths. The diameter of the largest spine found is one-tenth of an inch.

Affinities and Differences.—*Hemicidaris Purbeckensis* differs from *H. intermedia* and *crenularis* in having smaller and more numerous tubercles, in proportion to the size of the body, on the interambulacral areas, and a larger granulated intermediate space in their centres; the large tubercles on the ambulacral areas, instead of being closely set as in both the species named, are scattered and alternating; the number of pairs of pores opposite each large interambulacral plate are fewer. The ambulacra are nearly straight, instead of being undulated. Above all, the spines are quite distinct in their characters.

It differs from *H. stramonium*, a Portland oolite species, said by Mr. M'Coy to occur in England, in having a greater number of large ambulacral tubercles, wider ambulacral areas, and much smaller interambulacral tubercles.

. From *H. mitra*, also a foreign Portland oolite species, to which, like the last, it approaches in the straightness of the ambulacra, it differs in the arrangement of the interambulacral tubercles.

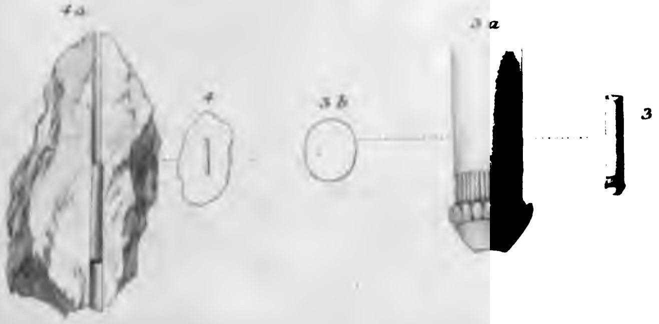
H. diademata and *Thurmanni*, foreign Kimmeridge species, have fewer interambulacral tubercles. The peculiar structure of the ambulacra of *H. alpina* sufficiently distinguish that species.

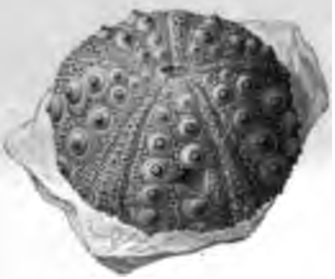
Since, except in the cases of *intermedia* and *crenularis*, the spines of the species I have mentioned are unknown, it is probable that when they shall have been found, the differences indicated will be accompanied by still more important distinctions.

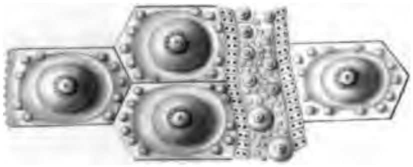
Locality and Geological Position.—This *Hemicidaris* is peculiarly interesting as being the first *Echinoderm* ever found in the PURBECKS. It was discovered by myself at Swanage in Dorsetshire, in December, 1849. For several days I had found the spines of an urchin with which I was unacquainted among the marine fossils which occur in a zone on the summit of the well-known "Cinder-bed," composed chiefly of *Ostrea*

eological Survey of the United Kingdom.

HEMICIDARIS
(Oolitic)







HEMICIDARIS PURBECKENSIS *Forbes.*

distorta, and constituting a conspicuous stratum in the middle division of the Purbecks. A careful search, during which I was rewarded by the discovery of several new forms of marine Purbeck mollusca, resulted in the finding of a very perfect specimen of the body of the *Hemicidaris*, now first described, accompanied by its spines, identical in structure with those previously observed. I have seen no traces of any other Purbeck echinoderm.

EXPLANATION OF THE PLATE.

Fig. 1. Body of the *Hemicidaris Purbeckensis.*

Fig. 2. Ambulacral and interambulacral plates.

Fig. 3. Base of a spine, natural size, 3 *a*, magnified. 3 *b* its section.

Figs. 4 and 4 *a*. Portions of the spines, natural size, indicating the dimensions and proportions of those organs.

Note on the Species of Hemicidaris found in British Strata.

At the time of the publication of Mr. Morris's "Catalogue of British Fossils" one species only of *Hemicidaris* was known as British. Since then two others have been enumerated by Professor M'Coy, in his paper "On some New Mesozoic Radiata," published in the "Annals of Natural History" for December, 1848.

I am acquainted with the following:—

1. *Hemicidaris intermedia*, Fleming; *H. crenularis* of British catalogues; common in the coralline oolite of Wiltshire; rare in Dorsetshire.—(*See* Decade III., pl. 4.)

2. *Hemicidaris Purbeckensis*, Forbes; the new Purbeck species now first described and figured.

3. *Hemicidaris alpina*, Agassiz. (Echin. Suiss. ii., p. 52, tab. 18, figs. 19–22.) A pretty species, easily distinguished from its congeners by the very small and thickly-set ambulacral tubercles. Our attention has been called to it by Mr. S. P. Woodward. It was found in the forest marble of Pickwick, Wilts, by Mr. Lowe of Chippenham.

4. *Hemicidaris pustulosa*, Forbes. A very fine new species from the great oolite of Minchinhampton. It forms part of the collection of Mr. Lycett, and is figured in Plate A, fig. 8, of the Monograph of Great Oolite Fossils to be published by the Palæontological Society. Its nearest ally is the *Hemicidaris diademata* of Agassiz, which it resembles in the sudden diminution and very small size of the uppermost interambulacral tubercles, but differs in having the sutural granulated space of the interambulacral areas very wide.

5. *Hemicidaris icaunensis*, Cotteau. (Echin. Foss. du Dep^t. de l'Yonne, plate 3, figs. 1–5.)? I have provisionally identified with the species cited a great oolite urchin from Minchinhampton, in Mr. Lycett's collection. It is figured in plate A, fig. 9, of the Monograph of Great Oolite Fossils, published by the Palæontological Society.

6. *Hemicidaris confluens*, M'Coy. In the Monograph already quoted a great oolite Minchinhampton urchin is figured in plate A, fig. 10, which seems to agree with the description of this species.

7. *Hemicidaris*, Sp. Nov.? In the collection of the Museum of Practical Geology. Found in the cornbrash in a lane leading from Stourton Caundle to Lower Woodacre, by Mr. Bristow, of the Geological Survey. This is a fine species, very distinct from any other British one, resembling most nearly *H. intermedia*, but differing in having gradually (not suddenly) increasing ambulacral areas, with the tubercles upon them set

well apart, except below, where the larger ones are closely packed. Until the spines shall have been discovered I hesitate to give a name to this form, since it so closely agrees with the figure of the Swiss *H. crenularis.*

8. *Hemicidaris,* Sp. Nov.?—A small depressed form, with very large interambulacral tubercles, and the larger tubercles upon the ambulacral areas occupying half their length. It is imperfect, but probably distinct. It was found in the cornbrash in Dorsetshire, and is contained in the Museum of Economic Geology.

The following I have not seen:—

9. *Hemicidaris stramonium,* of Agassiz; said by Professor M'Coy to be found in the coralline oolite of Calne, Wilts. On the Continent it is known only from the strata above the Kimmeridge.

EDWARD FORBES.

June, 1850.

BRITISH FOSSILS.

DECADE III. PLATE VI.

GALERITES (HOLECTYPUS) HEMISPHÆRICUS.

[Genus GALERITES. Lamarck. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cassidulidæ.) Body more or less hemispherical, always tumid; ambulacra simple, continuous, radiant; mouth central, inferior; anus inferior or sub-marginal; tubercles perforate.]

[Sub-genus *Holectypus*. Body hemispheric, circular; tubercles in regular series; inside without ribs.]

Synonyms. *Discoidea hemisphærica*, Agassiz, Cat. Syst., p. 7. Desor, Monog. des Galerites, p. 71, pl. 8, figs. 4–7 (1842). *Holectypus hemisphæricus*, Agassiz and Desor, Cat. Raisonné des Echinides, Ann. des Sciences Nat., 3rd Series, vol. vii., p. 146.

Var. β. *Depressus*. *Discoidea marginalis*, M'Coy, Ann. Nat. Hist., 2nd Series, vol. ii., p. 413 (1848).

Var. γ. *Conicus*, *anus valde marginalis*. *Holectypus devauxianus* Cotteau, Etudes sur les Echinides Fossiles, p. 46, pl. 2, figs. 7–9 (1850).

Diagnosis. *G.* (*H.*) *testâ tumidâ, hæmisphæricâ, plus minusve depressâ, margine rotundato; ano marginali; tuberculis in facie ventrali crebris, ad orem semsim majoribus.*

The genus *Holectypus* has been founded by M. Desor for such oolitic *Galerites* as have the aspect and regular arrangement of tubercles distinguishing the genus *Discoidea*, but have not the internal ribs which cause such deep indentations in the casts of specimens of the latter group. They constitute a transition from the *Discoideæ* to the typical *Galerites*, and, according to my views, form a section or sub-genus of the genus *Galerites*, more valuable on account of their palæontological merits and limited distribution in time (being in the main characteristic of the oolitic period) than for the zoological importance of the characters of their organization, which are rather transitional than distinctive.

The type of the sub-genus *Holectypus* is the *Galerites depressus*, a fossil very abundant in British oolites, and having wide vertical and horizontal range. The species now figured is conspicuously distinguished from *G. depressus* by having a marginal instead of a vertical anus, and the tubercles of its under surface very numerous and gradually enlarging towards the mouth, instead of being comparatively few and suddenly becoming large and scattered in that region. Its body is also more rounded and tumid at the margin, although that character varies slightly according to the degree of convexity of the dorsal surface.

The only *Holectypus* described in the Monograph of the Galerites by Desor, with a marginal anus, is the *H. hemisphæricus*, and the figures and description given by that author are sufficiently characteristic of the British species now under examination, so that I do not hesitate to adopt Desor's name. Its general outline is sub-hemispherical, varying in convexity in different individuals. Specimens are rarely quite regularly convex, but most commonly have a slight obliquity, and are very slightly elongated and declining on the side towards the anus; consequently the vertex in such examples is not quite central, though constantly apical.* The sides are gently tumid, so as to round off the margins gradually. The ventral surface is more or less hollowed out in the centre, often very much so. In the depth of the concavity, and nearly or quite central, is the mouth, occupying less than one-third of the disk, round, with ten deep marginated notches separated by gently curved interspaces, and placed close to the junctions of the interambulacral areas with the ambulacral avenues. The ambulacral areas are a third or more of the breadth of the interambulacrals, their proportionate dimensions increasing generally with the altitude of the individual, and lessening usually with age and size. The pairs of pores of the avenues are ranged in single file; they are slightly more distant from each other on the under than on the upper surface, but those very near the mouth are closely set again. There are about four pairs, or four and part of a fifth, opposite each interambulacral plate towards the middle of the upper sides. In a specimen slightly above an inch in diameter, I counted twenty-six interambulacral plates in a series, and ninety-four ambulacrals, each of the latter representing a pair of pores. Each of the interambulacral plates is thickly studded with minute granules, in the midst of which are the spiniferous tubercles, scattered and varying in number in different individuals. I have found some specimens, closely alike in all other respects, varying in the number and arrangement of these tubercles, of which there are sometimes two rows on a plate, at others only one. In those examples which present the most regular arrangements, the tubercles are so disposed on the assemblage of interambulacral plates, that each half area exhibits a curved line of them rising to alternate at the suture with a similar curved line on the corresponding half area. On the ambulacral areas the tubercles are also present, forming more or less regular oblique rows of three, sometimes of two, and with but slight traces of arrangement. The tubercles become crowded towards the margin, and are thickly distributed on the ventral surface, very regularly increasing in size towards the mouth, immediately around which they are often fewer again and more wide apart. Each tubercle is perforated on its summit, and has its base borne upon an areolated boss. In very complete specimens, the margin of the areola is surrounded by a ring of areolated granules, which, when highly magnified, exhibit traces of perforations on their summits, as represented in the plate. The spines are unknown.

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* I use the term "vertex" to denote the highest point of the back, and "apex" to indicate that point to which the ambulacra converge and where we find the ovarian disk.

The apical disk is formed of five genital and five ocular plates. The odd genital plate, that opposite the anal interambulacral area, is smaller than the rest, and imperforate. The other four are conspicuously perforated for the oviducts. The left genital plate is larger than the rest, occupies the centre of the disk, and is formed in part of the madreporiform tubercle, which in some specimens is very prominent and always conspicuous. The eye-plates are small and pentagonal; they are, as usual, placed opposite the terminations of the avenues, and are perforate at their lower parts, but still at some little distance from their margins, by the eye-holes, which in this species are large and conspicuous. [In Plate II., fig. 7, of Desor's Monograph of *Galerites*, the eye-holes of *G.* (*Holectypus*) *depressus* are represented as marginal, but an examination of them in British specimens of that species has convinced me that their true position is such as I now describe in *G. hemisphæricus*. The madreporiform body is there described as distinct from the ovarian plates, and the imperforated ovarian plate as largest in the circle, both which statements are, as I interpret the structure, errors.] The anus is placed in the lower and marginal half of the odd interambulacral area; it is pointed above, rounded below, so that its general outline is somewhat pyriform, or rather drop-shaped. In what may be considered normal examples, its widest diameter is about equal to the distance between its lower margin and the mouth; but almost every specimen varies slightly in this respect, and the result of an examination of more than fifty specimens has convinced me that, further than the constant marginality of the anus, the exact proportion its lower part bears to the ventral disk is not to be received as a specific character. Its breadth also varies in different individuals, in all other respects exactly similar.

Varieties.—Variations in convexity and in proportion of breadth to height are very conspicuous in this species, and among a number of specimens from any one locality very few will be found in this respect exactly alike. The other points of variation are the distance between the anus and the mouth, and the number and regularity of the tubercles.

There are three principal forms conspicuous among these varieties, which, if separated from each other in collections, might seem specifically distinct, but between which every gradation of transition may be found. The first of these is the more or less regular sub-depressed hemispheric form, most common, and apparently the normal one. Its most convex state closely approaches the conical variety, which is represented in the original figure of *Discoidea hæmisphærica.* This, on one side, passes into a small very convex variety, having the anus more than usually marginal, in which state it appears to constitute the *Holectypus devauxianus* of Cotteau, with whose figures and descriptions we have English specimens perfectly according. On the other side it becomes more and more depressed, until we get it only gently convex on the back. Specimens of this kind seem to have constituted the *Discoidea marginalis* of M'Coy, said to be "very abundant in the inferior oolite of Bridport," and respecting the identity of which with the species here described I entertain not the slightest doubt. In order to show the variations of dimensions in this species, I give the following measurements of ten Dorsetshire specimens in the collections of the Geological Survey:—

No.	Locality.	Breadth.	Height.	Anus to Mouth.
		Inch.	Inch.	Inch.
1	Stoke Knaps (β) . . .	1	$0\frac{6}{12}$	$0\frac{3}{12}$
2	Loders	$1\frac{1}{12}$	$0\frac{1}{12}$	$0\frac{2\frac{1}{2}}{12}$
3	Crewkerne	$1\frac{2}{12}$	$0\frac{5}{12}$	$0\frac{3}{12}$
4	Crewkerne	$1\frac{1}{12}$	$0\frac{6}{12}$	$0\frac{2\frac{1}{2}}{12}$
5	Stoke Knaps	$1\frac{4}{12}$	$0\frac{6}{12}$	$0\frac{3}{12}$
6	North Nibley . . .	$1\frac{2}{12}$	$0\frac{6\frac{1}{2}}{12}$	$0\frac{2\frac{1}{2}}{12}$
7	Castle Cary (γ) . . .	$0\frac{8}{12}$	$0\frac{7}{12}$	$0\frac{3}{12}$
8	Stoke Knaps (γ) . . .	$0\frac{9}{12}$	$0\frac{6}{12}$	$0\frac{3}{12}$
9	Shipton Gorge . . .	$0\frac{10}{12}$	$0\frac{5}{12}$	$0\frac{2\frac{1}{2}}{12}$
10	Bridport Harbour (γ) .	$0\frac{7}{12}$	$0\frac{4}{12}$	$0\frac{2}{12}$

Locality and Geological Position.—During the examination of the INFERIOR OOLITE strata in Somersetshire and Dorsetshire by the members of the Geological Survey, this species was collected abundantly, chiefly in the sands of the Inferior Oolite, in numerous places, associated in most instances with *Dysaster ringens* and often *Dysaster bicordatus.* The following is a list of the principal localities in which it was found: Hazelbury, Crewkerne, Lyttelton Hill near Cadbury, Whatley near Frome, Little Windsor, Loders (top beds), Stoke Knaps, Greenland, Compton Pauncefoot (bottom beds), Pilcombe, Bruton, Shipton Gorge,

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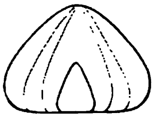

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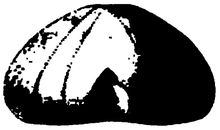

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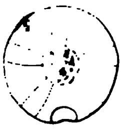

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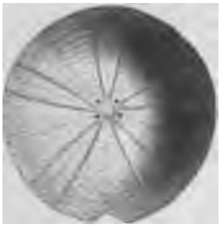

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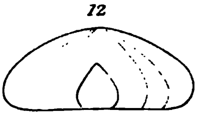

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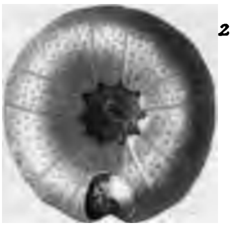

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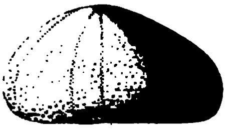

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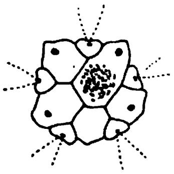

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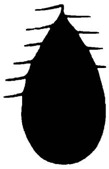

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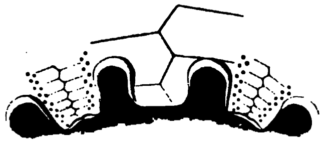

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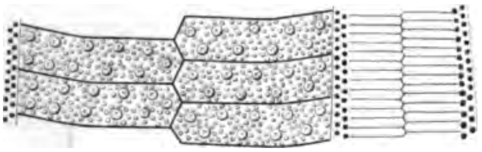

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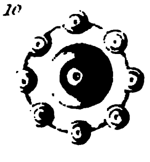

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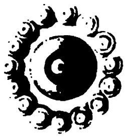

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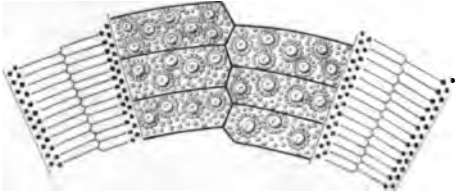


GALERITES (HOLECTYPUS) HEMISPHÆRICUS Agassiz.

Burton Bradstock, and near Burton Castle (top beds), Bridport Harbour, Chideock Hill, Mapperton, West Swillets, Beaminster. These localities are all included in sheets 18 and 19 of the Ordnance Map of England. The specimens were collected by Mr. Bristow and Mr. Gapper.

Foreign Distribution.—"In Normandy, in a particular bed of the Calcaire au Polypiers, known by the name of Caillasse." (Desor.) "In the Inferior Oolite of the Tour-du-Pré associated with *Dysaster ringens* and *Diadema depressum.*" (Cotteau.)

EXPLANATION OF THE PLATE.

Fig. 1. Normal form seen from above.

Fig. 2. Under view.

Fig. 3. End view, showing the anus.

Fig. 4. Profile.

Fig. 12. Extremely depressed specimen (var. β), seen endways.

Figs. 13 and 14. Outlines of end, over and under side of extremity, conical dwarf variety (var. γ).

Fig. 5. Arrangement of ambulacral and interambulacral plates and pores on the sides.

Fig. 6. Ditto on the base.

Fig. 7. Mode of duplication of the notches of the mouth-margins; and arrangement of the oral terminations of the avenues.

Fig. 8. Apical disk, showing the arrangement of the genital and ocular plates, and the madreporiform tubercle.

Fig. 10. Tubercle and granules of dorsal surface highly magnified.

Fig. 11. The same from the ventral surface.

Note on allied species of Galerites found in Britain.

The only British *Galerites* of the section *Holectypus,* besides the one described above, is the *G. depressa,* a species which accompanies *G. hemisphærica* in most of the localities cited, and which has a much wider distribution, occurring, in England, in inferior oolite, where it appears to be most abundant, in fullers' earth and in cornbrash. It is at once distinguished from *G. hemisphærica* by the position of the anus, which is entirely ventral, very large, extending from very near the mouth to the margin of the under surface, and of an oblong pyriform shape, pointed at its inner end, and widest towards its marginal termination a little beyond half its length. The dorsal surface is depressed, yet regularly convex, the margins rounded, but having a tendency to compression, consequently the greatest breadth of the entire body is in the diameter immediately above the margin. The spiniferous tubercles of the dorsal surface are very small; they are very numerous near the edge, but become fewer and more scattered, though very conspicuous and comparatively large, on the ventral surface, as they approach the mouth. Individuals vary greatly in the degree of dorsal convexity. From one inch to one inch and a-half across is the usual diameter of well-grown specimens.

EDWARD FORBES.

June, 1850.

BRITISH FOSSILS.

DECADE III. PLATE VII.

GALERITES (GALERITES) CASTANEA.

[Genus GALERITES. LAMARCK. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cassidulidæ.) Body more or less hemispherical, always tumid; ambulacra simple, continuous, radiant; mouth central, inferior; anus inferior or submarginal; tubercles perforate.]

[Sub-genus *Galerites*. Body hemispheric, sub-globose, or conical; base more or less flattened; tubercles irregularly arranged.]

SYNONYMS. FORMA *a. major.*—*Nucleolites castanea*, ALEX. BRONGNIART, Env. de Paris, pp. 100 and 349, pl. 9, fig. 14. *Catopygus castanea*, AGASSIZ, Prodr. Ech., p. 18. *Pyrina castanea*, DESMOULINS, Tabl. Synon. des Echin., p. 258. *Galerites castanea*, AGASSIZ, Cat. Syst. Ech., p. 7; and Ech. Foss. de la Suisse, 1st part, p. 77, pl. 12, figs. 7, 9. DESOR, Monog. des Galerites, p. 23, pl. 4, figs. 12–16. AGASSIZ and DESOR, Cat. Rais. des Echin. Ann. Sc. Nat., 3rd series, vol. vii., p. 149. *Galerites Rothomagensis*, AGASSIZ, Cat. Syst., p. 7, (*fide* DESOR).

FORMA *β. minor.*—*Nucleolites depressa*, ALEX. BRONGNIART, Env. de Paris, p. 400, pl. 9, f. 17. *Catopygus depressus*, AGASSIZ, Prodr., p. 18. *Pyrina depressa*, DESMOULINS, Tab. Synon., p. 258. DESOR, Monog. des Galerites, p. 28. AGASSIZ and DESOR, Cat. Rais. des Echin., Ann. Sc. Nat., 3rd series, vol. vii., p. 150. *Galerites castanea*, AGASSIZ, Cat. Syst., p. 7 in part (*fide* DESOR). *Galerites rothomagensis*, E. SISMONDA, Echin. Foss. Nizza, p. 51, pl. 2, figs. 8–10. *Galerites lævis*, AGASSIZ, Cat. Syst., p. 72.? DESOR, Monog. des Galerites, p. 24, pl. 4, figs. 8–11.?

DIAGNOSIS. *G. corpore depresso, ovato seu suborbiculari, lateribus rotundatis; ano postico, supra-marginali; tuberculis omnibus sub-æqualibus; poris ambulacralibus ad orem laxe confertis.*

In the "Geology of the Environs of Paris" there are two cretaceous urchins from Savoy, figured under the names of *Nucleolites castanea* and *Nucleolites depressa*, which I take to be varieties of one species of *Galerites*, and to be identical with that which is here described and figured. The slight distinction in the degree of elevation of the anus above the margin, noticed by Brongniart, was not sufficient to establish a specific difference; and as the smaller form was styled *depressa* under the belief that it might be the *Galerites depressus* of Lamarck, the specific name *castanea* is adopted for both varieties.

This view, however, is not taken by continental authors, though originally held by Agassiz, who, in his Systematic Catalogue, regarded the *Nucleolites depressa* of Brongniart as one with that author's *N. castanea*, and placed them both under the name *Galerites castanea.* Desmoulins, in his "Tableaux Synonymiques," enumerates both as distinct, and places them in the genus *Pyrina.* Desor, in his Monograph of the *Galerites*, identifies *G. castanea* with the *Galerites rothomagensis* of Agassiz's Catalogue, but places in the genus *Pyrina* the *Nucleolites depressa* of Brongniart. In the "Catalogue Raisonné des Echinides" the authors keep the *G. rothomagensis* and *G. castanea* under the latter name, and refer to the figures of the former and descriptions of both species in E. Sismonda's "Memoirs on the Fossil Echinidæ of Nice." In that work the figures of *G. rothomagensis* accord excellently with the British species before us, and the author remarks that the distinctions between the two are very slight indeed: "Non è che per leggerissime modificazioni dei principali caratteri, che questa specie puo staccarsi dal *Galerites castanea.* di cui la tutto l'abito." Yet, assuredly, the Italian species is much closer to the original figures of "*Nucleolites*" *depressa* than to those of *Galerites castanea.* Such, in brief, is the history of our species, which, in England however, is not likely to be confounded with any other member of its genus, or to be regarded as a member of any other sub-genus than that to which we have assigned it.

The figures of the *Galerites lævis* of Agassiz in Desor's Monograph have all the appearance of being representations of a variety of this species which occurs at Warminster. M. Desor describes and figures it from the only specimen he had met with—one in the collection of M. Deshayes, from cretaceous strata in France. Mr. M'Coy, in his additions to Morris's Catalogue, mentions both *Galerites castanea* and *Galerites lævis* as British species.

British specimens of this species almost all belong to the small variety, and those which I have examined and figured are of an ovate or suborbicular form, inclining to obtusely pentagular or hexangular. They vary much in the degree of tumidity and height as compared with the length and breadth, being sometimes nearly convex on the summit, at others depressed. The obscure angles, when they are five, correspond to the ambulacral areas; when there is a sixth, it is in the centre of the posterior or odd interambulacral space. The interambulacral areas exceed the breadth of the ambulacral by three-fifths on the middle of the sides. The sides are so rounded that their most tumid portions are central or sub-central. The base is flattened in the centre, rounded off at the sides, and has the mouth nearly in its middle. The mouth is rather small, rounded, and obscurely decagonal. The anus is elliptical, one-third greater in vertical dimensions than the mouth, and is placed at the hinder extremity in the lower part of the posterior interambulacral area immediately above the margin. It varies a little in degree of elevation in different specimens. Its margins are occasionally, though rarely, slightly thickened. The plates, both dorsal and ventral, are thickly covered with miliary granules, among which are distributed the spiniferous tubercles, perforated and placed on a crenulated protuberance within an areola. These tubercles are very little smaller on the dorsal surface than they are on the ventral. On the centro-lateral interambulacral plates there are from 15 to 30 tubercles. On the interambulacral areas they fall into obscure oblique ranks of three or four. In a specimen six-tenths, of an inch in height, there are about 22 rows of plates to each half of an interambulacral area, and about six ambulacral plates with as many pairs of pores to each of the former.

The apical disk is composed of five genital and five ocular plates; four of the former are perforated, and one, the posterior one, imperforated and small. The left anterior genital plate is larger than the others, and produced to form the central madreporiform plate. The remainder of the disk is granulated with scattered miliary tubercles. All the ocular plates are perforated. The pairs of pores are in single file on the back and sides; but when they turn the margin to proceed down the under surface to the mouth, they gradually fall into ranks of three pair, always very oblique, and never very closely set. The spines are unknown. Internal casts exhibit the ambulacra in prominent relief.

The larger variety is found at Warminster, and is more depressed usually than the smaller. In no essential character do they differ from each other.

The following measurements of six specimens will show the variability of proportions:—

	1 (α)	2 (β)	3 (β)	4 (β)	5 (β)	6 (β)
Length . .	$1\frac{3}{12}$	$0\frac{11}{12}$	$0\frac{11}{12}$	1	$0\frac{11}{12}$	$0\frac{9}{12}$
Breadth . .	$1\frac{1}{12}$	$0\frac{9}{12}$	$0\frac{10}{12}$	$0\frac{11}{12}$	$0\frac{10}{12}$	$0\frac{9}{12}$
Height . .	$0\frac{7}{12}$	$0\frac{7}{12}$	$0\frac{8}{12}$	$0\frac{9}{12}$	$0\frac{6}{12}$	$0\frac{6}{12}$

Localities and Geological Position.—This *Galerites* is characteristic of the bed of chalk marl, tinged green, with scattered particles of silicate of iron, which occurs, occupying a thickness frequently of two or three feet, at the junction of the chalk marl and green sand, and which has been described by Captain Ibbetson under the name of CHLORITIC

MARL. It is a very remarkable stratum, abounding in peculiar fossils, and containing numerous echinoderms. I have examined it and found the small variety of *Galerites castanea* plentifully near the village of Chaldon, in Dorsetshire. Mr. Morris and Captain Ibbetson have collected it in a corresponding geological position in several localities of the same county. Both larger and smaller varieties occur near Warminster.

Foreign Distribution.—In Savoy and in Normandy, apparently always in the same geological horizon as in England.

DESCRIPTION OF THE PLATE.

Figs. 1, 2, 3, 4. Various positions of a perfect example from Dorsetshire of the tumid form of var. *Minor*.

Fig. 5. Internal cast.

Fig. 6. Ambulacral and interambulacral plates and their sculpture, taken from the centre of the sides.

Fig. 7. Arrangement of the pairs of pores in the neighbourhood of the mouth.

Fig. 8. Diagram showing the relative position of the pores and avenues.

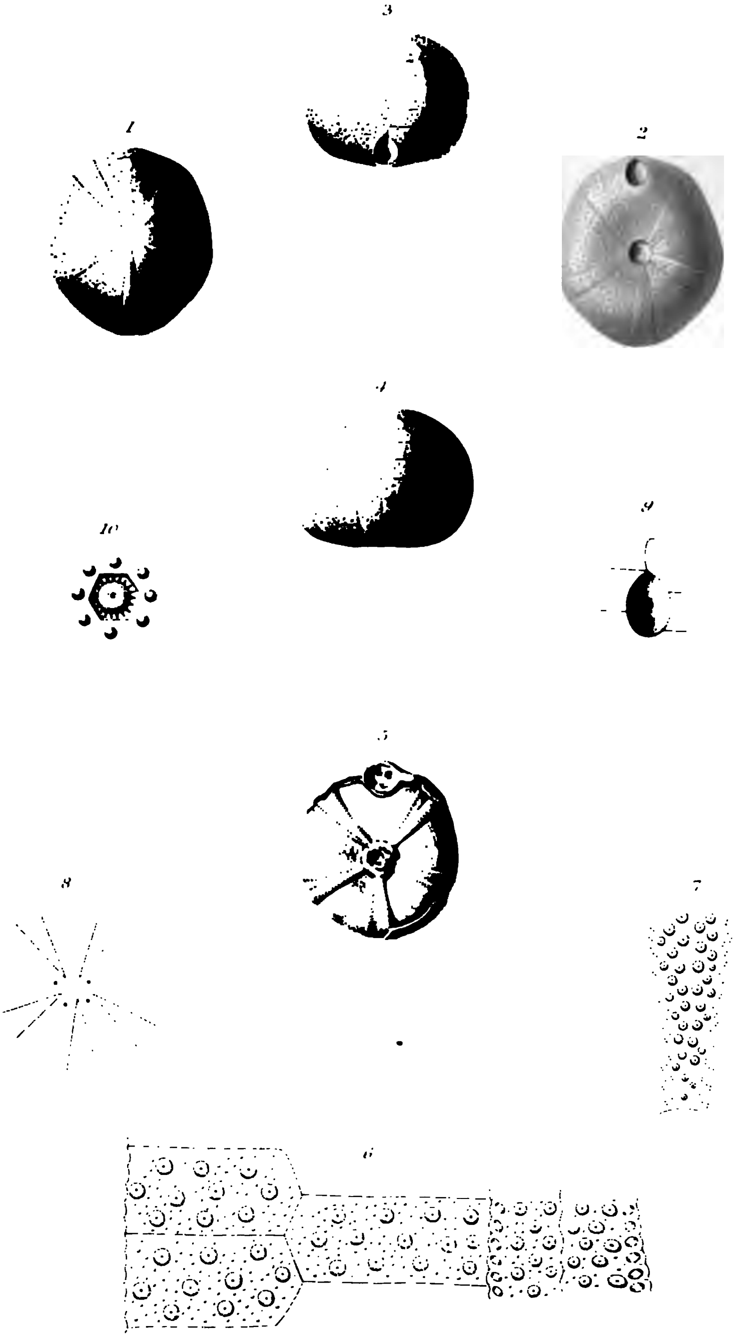
Fig. 9. Anus.

Fig. 10. Primary tubercle and granules, highly magnified.

EDWARD FORBES.

June, 1850.

GALERI
Cretaceo



GALERITES CASTANEA *Brongniart*.

BRITISH FOSSILS.

Decade III. Plate VIII.

GALERITES (GALERITES) ALBOGALERUS.

[Genus GALERITES. Lamarck. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cassidulidæ.) Body more or less hemispherical, always tumid; ambulacra simple, continuous, radiant; mouth central, inferior; anus inferior or submarginal; tubercles perforate.]

[Sub-genus *Galerites*. Body hemispheric, sub-globose, or conical; base more or less flattened; tubercles irregularly arranged.]

Synonyms. *Conulus albogalerus*, Leske, ap Klein, p. 162, pl. 13, figs. A, B. *Echinus albo-galerus*, Gmelin, p. 3181, No. 46. *Galerites albo-galerus*, Lamarck, vol. iii., p. 306; Desmoulins, Tab. Syn. p. 248; Goldfuss, Pet. Genn., p. 127, pl. 40, fig. 19; Stokes, Geol. Trans., 2nd series, vol. ii., p. 406, pl. 45, figs. 14, 15; Desor, Monog. des Galerites, p. 4, pl. 1, figs. 4–11, and 13, fig. 7; Agassiz and Desor, Cat. Rais. des Echin., Ann. des Sciences Nat., 3rd ser., vol. vii., p. 148. *Conulus albogalerus*, Fleming, Brit. An. p. 481; Mantell, Geol. Sussex, pl. 17, figs. 8, 20; Parkinson, Org. Rem., vol. iii., pl. 2, figs. 10, 11. *Echinoneus albo-galerus*, De Blainville, Zooph., p. 194. *Discoidea albogalera*. Agassiz, Prod., p. 186; Bronn, Lethæa Geog., p. 614, pl. 29, fig. 18 *a*, *b*. *Galerites cretosus*, Mantell, Medals, vol. i., p. 384.

Forma α. *Normalis*. (The figures quoted above represent the typical form.)

Forma β. *Tumidior*. *Galerites conica*, Agassiz; Desor, Monog. des Galerites, p. 16, pl. 1, figs. 12–19. *Conulus albogalerus*, Mantell, Geol. Sussex, pl. 17, figs. 8 and 20.

Diagnosis. *G. corpore alto, conoideo, ad basin angulato tuberculis infrâ majoribus; ano elliptico, infero, submarginali, margine incrassato subrostrato; poris ambulacralibus ad orem compacte confertis.*

The general form of the *Galerites albogalerus* is that of a sugar-loaf, pyramidal or conical, with a flattened base; varying from a tall pyramid with very steep sides to a short one with swelling sides, always compressed and subangular at the junction of the sides or dorsal surface with the base or ventral surface. Above, it is divided into ten areas by the straight radiating avenues of pores; the interambulacral areas a little below the centre of the sides are equal to from three to three and a-half of the ambulacral areas. In a specimen an inch and four-twelfths high, about 15 plates constituted each half of a dorsal interambulacral area, and about 75 each half of an ambulacral. The greater number of interambulacral plates are nearly equal in vertical diameter, but widen out in transverse dimensions from apex to base. The ambulacrals are minute, and often cuneiform, and are separated from each other not unfrequently by small accessory plates. Rather more than four of the former are equal to the length of the interambulacral plate opposite them. All the dorsal plates are covered with very minute miliary granules, which give but very slight or scarcely any roughness to the surface when it is denuded of spines. These are interspersed with small spiniferous tubercles, numerous, scattered, but presenting an hour-glass like arrangement on each interambulacral plate, one or two on each ambulacral. Each of these spiniferous tubercles is perforated on the apex, and placed on a mammilliform boss with a crenulated summit, and surrounded by a smooth areola.

The base is flat. Its ambulacral and interambulacral areas are studded with numerous spiniferous tubercles larger than those of the dorsal surface; in the former they form oblique rows of fours or at most five, across the whole of each ambulacral space near the margin, and diminishing in number towards the mouth; in the latter they are thickly crowded towards the margin, and ranged towards the mouth in oblong transverse groups, interrupted by raised granulated wavy spaces, which mark the lines of junction of the plates, and forming an arachnoid arrangement of irregular rings on the base, of which the mouth is the centre. The base is elongated posteally, thickened and subrostrated for the anus, which is large and broadly elliptical in a longitudinal direction. Its margins are raised and thick. The size of the vent usually exceeds that of the mouth by one-third. The mouth appears round, but is obscurely decagonal, being gently notched at its margins opposite the avenues of pores. It is inflexed opposite each area, the inflections opposite the interambulacral areas being deeper and semicircular. The pairs of pores are small, ranged in single file down the dorsal surface, falling into series of three pairs on the base soon after passing the margin. The series become more and more oblique until, at the tenth or eleventh from the base, they are directly under each other, and consequently give considerable breadth to the avenues. Three lines drawn up each avenue in the inner half of its basal course will intersect one of the pair of pores of each series.

The miliary tubercles of the dorsal plates bear very minute and short tubercular smooth spines, each standing apart from its neighbours. The spines on the tubercles of the upper surface I have not seen.

Those of the lower surface are two-tenths of an inch in length, slender, tapering, smooth, longitudinally ridged with about eight ridges and enlarged at the base, where they are surrounded by a crenulated collar. Curious club-tipped pedicellaria-like bodies occur among them, which may represent the spines of the miliary tubercles described as occurring on the dorsal surface.

Mr. Bowerbank has communicated the result of a microscopic examination of the spines of *Galerites* in his possession. He finds the small dorsal spines of *Galerites albogalerus* to differ from those of *subrotundus* in being thickened at the base and set on the tubercles as it were sessile, instead of being shortly pedunculated, as they are in the latter species. The minute moniliform spines of *G. albogalerus* are $\frac{1}{150}$ of an inch in length and of equal diameter. Three were measured, and all were as nearly as possible of the same size and proportions. They were all perfectly smooth.

The apex of the body is the highest point of the back. The apical disk is formed of five genital and five ocular plates. Four of the former are perforated for the oviducts in their lower halves; one of the perforated plates is greatly enlarged above, to form the centre of the disk, where it is wrinkled and punctured, constituting the madreporiform plate. The fifth posterior and odd genital plate is very small, triangular, and imperforate. The perforations of all are nearly marginal.

The existence of a dental system in *Galerites* was made known by Mr. Charles Stokes, who communicated his discovery to the Geological Society. A second specimen with teeth adorns the collection of Mr. Bowerbank, and in it the dental "lantern" is sufficiently protruded to enable us to determine the form and structure of its principal elements. The teeth are smooth, white, lanceolate, triangular, each consisting of a concave lamina terminating below in the dental point, and strengthened on its back by a prominent rounded ridge. In the "Catalogue Raisonné des Echinides," the authors have by an oversight attributed as a character to the *Cassidulidæ*, the absence of a masticatory apparatus. It is probable that all the members of that family had a dental system similar to that of *Galerites*. The absence of traces of it in fossil specimens must be accounted for in the same way in which we know the absence of the dental lantern in dead specimens of existing *Echini* to have been caused, *viz.*, by the decay of the internal parts and the disarticulation of the segments of the masticatory apparatus.

The following table of the relative dimensions of nine specimens, among those in the collection of the Geological Survey, will give some idea of the variable proportions in this species.

No. of Specimen.	Length at Base.	Breadth at Base.	Height.	Lat. Diameter at a Fourth of the Height from the Apex..
	Inch.	Inch.	Inch.	Inch.
1	1 $\frac{2}{12}$	1 $\frac{1}{12}$	1 $\frac{2}{12}$	0 $\frac{8}{12}$
2	1 $\frac{7}{12}$	1 $\frac{6}{12}$	1 $\frac{6}{12}$	0 $\frac{11}{12}$
3	1 $\frac{8}{12}$	1 $\frac{5}{12}$	1 $\frac{5}{12}$	0 $\frac{10}{12}$
4	1 $\frac{8}{12}$	1 $\frac{5}{12}$	1 $\frac{3}{12}$	0 $\frac{8}{12}$
5	1 $\frac{7}{12}$	1 $\frac{6}{12}$	1 $\frac{3}{12}$	0 $\frac{8}{12}$
6	1 $\frac{8}{12}$	1 $\frac{4}{12}$	1 $\frac{2}{12}$	0 $\frac{9}{12}$
7	1 $\frac{4}{12}$	1 $\frac{2}{12}$	1 $\frac{1}{24}$	0 $\frac{6}{12}$
8	1 $\frac{9}{12}$	1 $\frac{7}{12}$	1 $\frac{3}{12}$	0 $\frac{10}{12}$
9	1 $\frac{2}{12}$	1 $\frac{1}{12}$	0 $\frac{9}{12}$	0 $\frac{7}{12}$

Affinities.—In the valuable Monograph of *Galerites* by M. Desor, there are eleven species of the genus (in its most restricted sense) enumerated, all of which would rank, according to the views we have adopted in these memoirs, as members of the sub-genus *Galerites*. Nine, if not the whole eleven of Desor's species are found in British cretaceous strata. After a careful consideration of figures, specimens, and citations, I have come to the conclusion that the whole eleven may be reduced to only four true species, one of them the *Galerites* before us, the other three very nearly allied forms. The species of the sub-genus *Galerites* which I recognize as truly entitled to that rank are the following:—

1st. *G. albogalerus;* first so named by Klein on account of its fancied resemblance to the white caps worn by the priests of Jupiter, the common form here figured and described in detail, previously noticed by many old writers and sometimes rudely figured; it was adopted into strict scientific nomenclature by Gmelin in the thirteenth edition of the "Systema Naturæ." There was never any mistake about the typical form of this species, and though the generic name has been frequently changed, the old and appropriate specific denomination has been held sacred and should be kept. I regret, therefore, that Dr. Mantell should have recently applied to it a new epithet—the word *cretaceus*, applicable to all the species of the sub-genus *Galerites*, in his excellent popular manual of Palæontology, the "Medals of Creation."

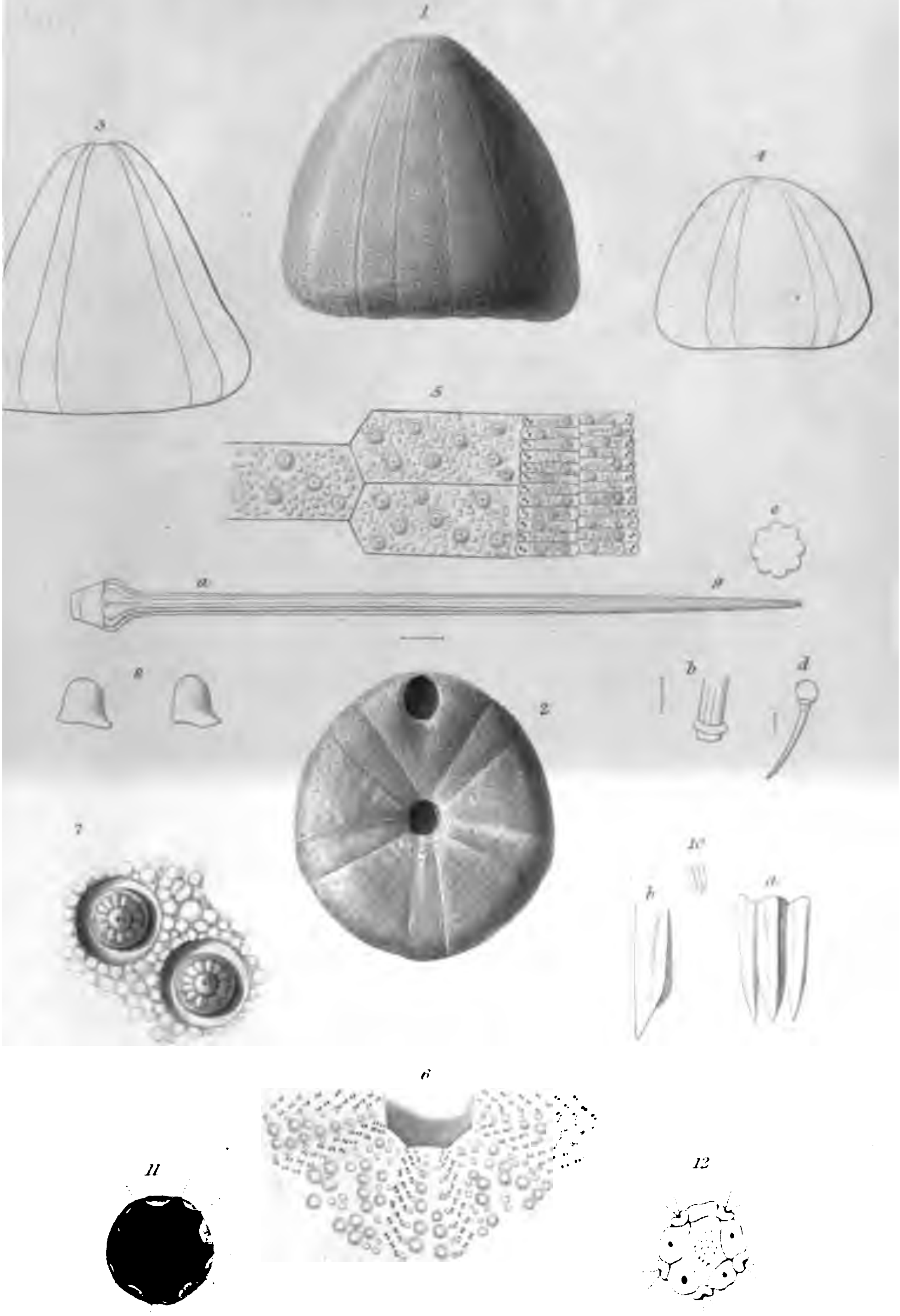
The fourth species in M. Desor's Monograph, is one of the commonest varieties of *albogalerus*, elevated to a species by Agassiz, under the name of *Galerites conica*. Every gradation of outline between it and the typical form (which is the more conical of the two) is to be met with abundantly in the English chalk. In describing it, M. Desor has carefully contrasted its characters with *G. vulgaris;* the distinctions he enumerates are those which separate the latter from *albogalerus.* He remarks, that possibly the *conica* may prove to be the male of *vulgaris.* For stratigraphical reasons, I do not think this can be the case, but were it so, then *albogalerus* as a whole must be taken as the male of *vulgaris.* It is more probable that the pyramidal and tumid forms of *albogalerus,* considered distinct by Agassiz and Desor, under the names *albogalerus* and *conica,* may be respectively male and female; but even this hypothesis I abstain from proposing, when I see the complete and gradual transition which specimens exhibit between the two extremes of form.

2. *G. abbreviatus.*—Certain old figures in the works of Klein, Leske, and others gave origin to the establishment of a *Galerites* under the names of *abbreviatus* (Lamarck), *truncatus* (Defrance), and (in part) *vulgaris.* The synonymy of this type is fully given by M. Desor, with excellent figures of one of its ordinary varieties (Monog. des Galerites, tab. 3, figs. 9-17). It is the *Galerites vulgaris* of Goldfuss and of Bronn, and another variety is the *Galerites abbreviatus* of the former author, which in the "Catalogue Raisonné," M. Desor elevates to distinct rank as *G. oblongus.* It is the *Conulus vulgaris* figured by Parkinson, and probably the species enumerated under that term by Mantell. Varieties of it are figured under the names of *Galerites vulgaris α* and *β*, by Woodward, in his "Geology of Norfolk," plate 5, figs. 2 and 3, as has been proved to me from specimens by my friend Mr. S. P. Woodward, of the British Museum, who has further indicated to me its identity with the *Galerites angulosa* of Desor (Monog. des Gal., plate 4, figs. 5-7), and *Carotomus hemisphæricus* of Desor (Monog. p. 37, plate 5, figs. 14, 15), both founded on well-known English specimens in the collection of the Marquis of Northampton, and of which I have examined exact parallels in the museum of Mr. Bowerbank, the former, indeed, being identical with *Galerites vulgaris* of the "Geology of Norfolk," and the latter with var. *β* of the same work. Moreover, I have scarcely a doubt that the *Galerites pyramidalis* of the "Monograph des Galerites," plate 1, figs. 1 to 3, founded on a single flint-cast—a most insufficient ground in this genus upon which to constitute a distinct species,—is also *Galerites abbreviatus.*

The number of spurious species which have thus been constituted out of one, is scarcely to be wondered at, when the extreme variability of its shape is considered. Of the specimens I have seen with the shell preserved no two are alike, and certainly the extremely depressed *Carotomus hemisphæricus* might very fairly be regarded as at least specifically distinct, were it not that characters sounder than mere outline, mark it as the same, and that all intermediate gradations of convexity may easily be shown. From *Galerites albogalerus* this species is truly distinguished by the constant rotundity of its basal margin, which is *tumidly rounded*, instead of being subangularly compressed. The ambulacral areas are usually prominent, often so much so as to give a strong angularity to the contour, and always narrower in proportion to the interambulacrals than in the other species. The anus is inferior, strongly and tumidly prominent and marginated, and always either *round* or *broader than long*, a character never present in its congeners. The whole surface above and below is rough with granulations, interspersed with the primary tubercles, which are *nearly equal* on the ventral and dorsal surfaces. The miliary granulation is quite as strong above as below, and strikingly contrasts with the apparent smoothness of the surface which distinguishes *albogalerus* and *subrotundus*. The margins of the mouth are usually tumid, and the avenues of pores when advancing to it, do not become so closely ranked as in the species just named. *Galerites abbreviatus* appears to be characteristic of the upper chalk.

3. *G. subrotundus.*—Although this name was given by Agassiz to a single English specimen, and previously by Mantell to a questionable cast, I prefer retaining it to using that of *vulgaris*, adopted, after Lamarck; by Agassiz and Desor, for what I regard as perhaps the more ordinary form of the same species. I reject the latter name, since under it so many good figures of the last species mentioned have been published, and adopt *subrotundus*, since one of its forms has been excellently figured under that name by Desor, and since it has not been applied to any other species. It is a common English Galerite, and apparently is chiefly confined to a lower geological horizon than that of the two preceding species, being chiefly characteristic of the hard or lower chalk. In form, it varies from a depressed spheroid with a truncated base to nearly globular; the anus is always vertically elliptical, not rostrated nor tumid, and is placed on, or in some occasional specimens, above the margin. The mouth is central. The margins of the sides are always more or less rounded. The spiniferous tubercles of the base are conspicuously larger than those of the dorsal surface, but all are smaller and more numerous than those of *albogalerus*. The spines of the lower surface are smaller and different. The pairs of pores fall into close ranks near the mouth, but are more oblique, and the series are not so directly under each other as in *albogalerus*. The *Galerites globulus* of Desor, founded on a single white-chalk English specimen, is a not rare but exceptional dwarf variety, and *Globator nucleus* of Agassiz is something too like an abnormality of this species. *Galerites Leskii* (Desor), is another variety.

4. *Galerites castanea*, with which I unite *Pyrina depressa* and *Galerites lævis*, possibly also *Galerites Orbignyana* (founded on a single specimen from Touraine) may fall in here. But of this fourth species I have fully treated in the account of *Galerites castanea*.



GALERITES ALBOGALERUS. _Klein.

I cannot reconcile the *Galerites globosus* and *Galerites elongatus* of F. A. Römer ("Versteinerungen des Norddeutchen Kreidegebirges," Pl. VI., figs. 14 and 15) with any of the above. The figures are, however, very bad, and it is not improbable that the former may prove identical with the *nucleus* variety of *subrotundus*, and the latter with some form of *abbreviatus*.

A fifth species of true *Galerites*, but one not hitherto found in Britain, is the *G. subsphæroidalis* of D'Archiac, described and figured in that geologist's excellent account of the fossils of the Tourtia. It is allied to *G. subrotundus*, but is perfectly distinct, and should be sought for in the upper beds of the English lower green-sand, where many Tourtia fossils occur.

Localities and Geological Position.—This species is found distributed throughout the white chalk of the English cretaceous districts. It is very abundant in the south. Very fine specimens are found in Kent, as at Gravesend, &c. Examples with spines are contained in the Museum of the Geological Survey, and in Mr. Bowerbank's collection. Specimens showing the teeth are in the collections of Mr. Stokes and Mr. Bowerbank. Some interesting forms have been presented to the Survey by Mr. Wetherell.

Foreign Localities.—White chalk of France, Germany, and Belgium, apparently not universally diffused through the spread of this formation.

Description of the Plate.

Fig. 1. Profile of the most common variety.

Fig. 2. The same seen from below.

Fig. 3. Outline (lateral view) of an extremely pyramidal specimen.

Fig. 4. Outline (lateral view) of an extremely depressed and tumid variety.

Fig. 5. Ambulacral and interambulacral plates, pores, and tubercles, taken from the centre of the sides.

Fig. 6. Arrangement of pores and tubercles in the neighbourhood of the mouth.

Fig. 7. Spiniferous tubercles and miliary granules taken from the base.

Fig. 8. Greatly magnified figures of the small tubercular spines of the dorso-lateral plates.

Fig. 9. *a.* One of the spines of the lower surface highly magnified. *c.* Its section. *d.* Pedicellaria-like body, intermixed with the spines. *b.* Portion of spine of *Galerites subrotundus* for comparison.

Fig. 10. Masticatory apparatus, natural size. *a.* The same seen from one side, highly magnified. *b.* One of the teeth seen in profile.

Fig. 11. Diagram of the supports of the masticatory apparatus around the inner rim of the mouth.

Fig. 12. Apical disk; genital and ocular plates.

Subgenera and Species of Galerites found in Britain.

Genus. GALERITES.

Subgenus I. GALERITES (the British species are all upper-cretaceous).
1. *albogalerus,* Klein.
2. *abbreviata,* Lamarck.
3. *subrotunda,* Mantell.
4. *castanea,* Brongniart.

Subgenus II. CAROTOMUS.
1. *rostrata,* Agassiz (upper green sand).

Subgenus III. DISCOIDEA (all the British species are cretaceous).
1. *cylindrica,* Lamarck.
2. *favrina,* Desor.
3. *subuculus,* Leske.
4. *Dixoni,* Forbes.

Subgenus IV. HOLECTYPUS (all the British species are oolitic).
1. *depressa,* Leske.
2. *hemisphærica,* Agassiz.

EDWARD FORBES.

June, 1850.

BRITISH FOSSILS.

DECADE III. PLATE IX.

DYSASTER RINGENS.

[Genus DYSASTER. AGASSIZ. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cassidulidæ.) Body sub-discoidal; ambulacra simple, continuous, radiant; the posterior lateral pair separated from the rest, and converging to form a summit distinct from that formed at the genital disk by the two antero-lateral and the anterior one; mouth sub-central, inferior; anus at the hinder extremity; tubercles perforate.]

SYNONYMS. ***Dysaster ringens*****, AGASSIZ, Ech. Foss. de la Suisse, 1st part, p. 5, t. 1, figs. 7–11 (1839); Cat. Syst., p. 3; DESOR, Monog. des Dysaster, p. 24, pl. 1, figs. 13–17; COTTEAU, Etudes sur les Echin. Foss., p. 46, pl. 2, figs. 10–13; AGASSIZ and DESOR, Cat. Rais. des Echin; Ann. des Sc. Nat., 3rd series, vol. viii., p. 33.** ***Collyrites ringens*****, DESMOULINS, 3rd Mem. sur les Echin., p. 368.** ***Dysaster Eudesii*****, AGASSIZ, Cat. Syst., p. 3; DESOR, Monog. des Dysaster, p. 23, pl. 1, figs. 5–12.** ***Dysaster subringens*****, M'COY, Annals Nat. Hist., 2nd series, vol. ii., p. 415 (1848).**

DIAGNOSIS. ***D. testâ depressâ orbiculari, seu subpentagonali, lateribus tumidis, dorso convexiusculo, vertice plerumque centrali; ambulacris postero-lateralibus supra anum convergentibus; ano in sulco terminali; ventro concavo, areis interambulacralibus tumidis, areâ postica gibbâ, ore subcentrali.***

The curious genus to which the fossil before us belongs, although of very late constitution, having been first founded by Agassiz in 1834, has scarcely as yet settled down into a decided position among sea-urchins. The species most anciently known were styled *Spatangites* by Leske, assigned to *Ananchytes* by Lamarck, and *Nucleolites* by Munster. Since *Dysaster* was constituted for their reception, it was first placed among the "Spatangoides" by Agassiz, referred to the "Clypeastroides" by Desor, and back again to the former family by Agassiz and Desor jointly. Very recently, M. Gustave Cotteau, in his excellent work on the fossil *Echinidæ* of the department de L'Yonne, has inclined to regard them as members of the Cassidulidæ. After an earnest consideration of their structural relations, I do not hesitate to place them in the last-named family, in which they have distinct and close affinity with *Hyboclypus* and *Galerites.* The form of the ambulacra, combined with the structure of the mouth, is sufficient to warrant such a conclusion. In the foreign *Dysaster semiglobus* (*Nucleolites* *semiglobus* of Munster) we see a species which is truly intermediate between such a *Galerites* as *G. castaneus* and the more typical forms of *Dysaster.*

British specimens of this *Dysaster* vary in outline from nearly completely circular to subpentagonal, with even an approach to oblong; every gradation between the two extremes of form is common. The dorsal surface is very uniformly and gently convex, though varying considerably in altitude. The highest point of the back is almost always a little behind the centre ; very rarely a specimen is met with having it still further back. The sides are tumid, and in the subpentagonal specimens, slightly and very obtusely angulated by the prominence of the interambulacral spaces. The ventral surface is concave in the region of the mouth, very convex, and almost nodulose in the interambulacral spaces; the ambulacral areas being depressed. The odd or anal interambulacral area is peculiarly prominent and gibbous. Its extremity is squared by the inferior terminations of two ridges which bound the conical groove, in the upper part of which, nearly, but not quite on a level with the dorsal surface of the body, is lodged the anus.

The three anterior ambulacra converge nearly in the centre of the back. The antero-laterals are separated on each side from the anterior ambulacrum by a perforated genital plate ; that of the left side is granulated in its upper part, being the madreporiform plate. Behind the summits of the antero-lateral ambulacra, which curve gently forwards before they terminate, are the other two genital holes. The eye-holes are very small, but distinctly terminate the three anterior ambulacra; the other two seem to be removed from the disk to the terminations of the postero-lateral ambulacra, but of this I have not clearly satisfied myself.

The ambulacra are all complete, running from the mouth to their dorsal terminations; on the back they are on a level with the interambulacral plates. The number of ambulacral plates exceeds that of the interambulacrals by four or five times. The three anterior ambulacra are narrower than the two posterior, which are often nearly but not quite twice as broad as the former; the proportionate width, however, as I have satisfied myself by measurements, is not constant. The narrowest ambulacrum towards its summit is the anterior one, but it widens out lower down. Each pair of ambulacral plates is perforated at its outer side by a pair of pores. Near the mouth the ambulacra widen, and the pairs of pores are ranked in about three oblique series of three pair in each, but their relations to the plates there are obscure. All the plates, whether ambulacral or interambulacral, are minutely granulated, and among the granules are interspersed very small spiniferous tubercles with areolæ and punctated summits; but whether the bosses on which they stand are crenulated I have not been able to make out satisfactorily in this species. The tubercles are most numerous below. The spines are unknown.

The mouth and anus are of about equal dimensions, being each in diameter rather less than one-eighth of the length of the shell. The position of the mouth is subcentral, but sometimes the eccentricity is considerable. It is very obscurely decagonal, but seems to the eye as if round. No traces of dental armature have as yet been discovered.

Varieties.—The specimens we have figured accord best with the representations of the *Dysaster Eudesii* of Agassiz, as figured in the Monograph by Desor. Many English examples are, however, sufficiently flattened out to represent very perfectly the *ringens* of that work. In the description of the species there given it is implied that the latter differs from the former importantly in the circumstance of its anterior ambulacra being narrower than the posterior; the figures of *D. Eudesii*, however, represent the ambulacra as presenting similar relative proportions with those of *ringens*. M. Cotteau refers this *Dysaster* of the "oolite ferrugineuse" of the Tour-du-Pré to the *ringens*. His figure would serve as a good representation of some of our English specimens. He remarks that he and M. Moreau have collected in a single locality a suite of examples of *D. ringens* presenting various degrees of tumidity and more or less circularity of outline, and among which were all the gradations conducting to *D. Eudesii* "qui ne serait alors qu'une varieté plus petite et plus allongée du *Dysaster ringens*." The experience of the Survey collectors leads me to the same conclusion.

Professor M'Coy, in his memoir "On some new Mesozoic Radiata," in the "Annals of Natural History" for December, 1848, has enumerated *D. Eudesii* as a British species from the inferior oolite of Dundry and Bridport. At the same time he describes two new species of *Dysaster* under the names of *D. symmetricus* and *D. subringens*; the former "not uncommon in the inferior oolite of Bridport," the latter "not uncommon in the inferior oolite of Dundry and Leckhampton." After a careful perusal of his descriptions, I am obliged to surmise that the latter species (an opinion supported, after comparison with the original specimen, by Mr. Salter), is a variety of the species now described. I can find no character in his descriptions which would warrant their specific separation; and, as in the case of his *subringens*, he compares it with *ringens* and *Eudesii*, distinguishing it from the former "by its greater gibbosity and the less prominence of the ridges on the under side," and from the latter "by the disproportionate narrowness of the three anterior ambulacra as in the *D. ringens*;" characters which vary in every specimen, I do not hesitate to include it among the synonyms of *ringens*. In the same paper he mentions *Dysaster avellana*, of Agassiz, as also from the inferior oolite of Bridport; I cannot satisfy myself, after examining

Desor's figures and descriptions, that the species in question is distinct from *D. bicordatus*; and certainly, industriously as the Survey collectors have ransacked the inferior oolites of Dorsetshire, I have never received any other species of *Dysaster* from thence, except *Dysaster ringens*, as here described, and *Dysaster bicordatus*, a very different form, of which Mr. M'Coy's *D. symmetricus* is an oval variety.

The following table of the dimensions of eight specimens, in inches and twelfths, from the Bridport oolite, will show the variable proportions of this species.

	A.	B.	C.	D.	E.	F.	G.	H.
Length . .	$1\frac{1}{12}$	$1\frac{1}{12}$	$0\frac{11}{12}$	$0\frac{8}{12}$	$0\frac{10}{12}$	$0\frac{9}{12}$	$0\frac{10}{12}$	$0\frac{10}{12}$
Breadth . .	1	$1\frac{1}{12}$	$0\frac{11}{12}$	$0\frac{8}{12}$	$0\frac{8}{12}$	$0\frac{8}{12}$	$0\frac{11}{12}$	$0\frac{11}{12}$
Thickness .	$0\frac{6}{12}$	$0\frac{5}{12}$	$0\frac{7}{12}$	$0\frac{5}{12}$	$0\frac{5}{12}$	$0\frac{5}{12}$	$0\frac{5}{12}$	$0\frac{6}{12}$

Localities and Geological Position.—This species has been collected abundantly by Mr. Bristow and Mr. Gapper during the examination in the course of the Geological Survey of the INFERIOR OOLITE of Somersetshire and Dorsetshire. It appears to occur chiefly in the sands of that formation, and is very generally the companion of *Galerites* (*Holectypus*) *hemisphærica*. Among the localities from whence I have examined specimens are the following: Lyttelton-hill, near South Cadbury; between Sherborne and Yeovil; Little Windsor; Stoke Knaps. Greenland (in the ferruginous beds), Loders; Whatley; Smokeham; Honeycombe; Bradford Abbas; Beaminster; Shipton Gorge, where it is accompanied by *Dysaster bicordatus*; Burton Bradstock; Burton Cliffs (top beds); near Bridport Harbour; Chideock-hill; Mapperton; West Swillets. The places mentioned are included in sheets 18 and 19 of the Ordnance Survey Map of England.

Foreign Distribution.—In the "*Marnes Vesuliennes*" of the Jura (Agassiz); in the ferruginous oolite of Normandy (Deslonchamps); in the ferruginous oolite of the Tour-du-Pré (Cotteau).

EXPLANATION OF THE PLATE.

Fig. 1. View of body seen from above.

Fig. 2. Underside of same specimen.

Fig 3. Terminal view.

Fig. 4. Terminal view of a wider specimen.

Figs. 5 and 6. Profile of variations in proportions of specimens.

Fig. 7. Diagram of structure of test, the plates of the disk and those above the anus not made out.

8. Oral terminations of the ambulacra, showing the triplication of the pores.

9. Relative proportions of ambulacral and interambulacral plates, taken from the sides.

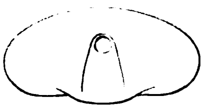
10. Tubercles and granules of surface.

11. Genital disk, terminations of anterior ambulacra, and madreporiform plate.

June, 1850. EDWARD FORBES.

DYSASTER
(Oolitic)

4



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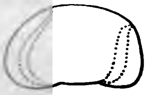

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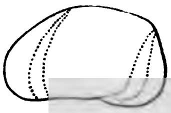

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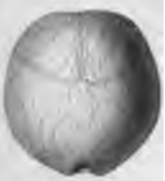

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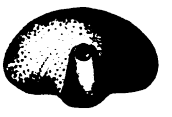

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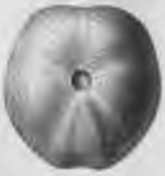

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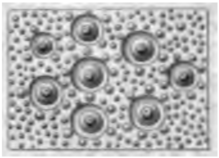

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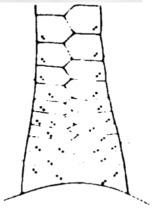

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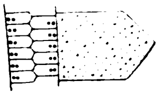

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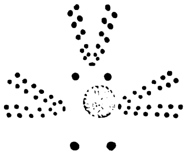

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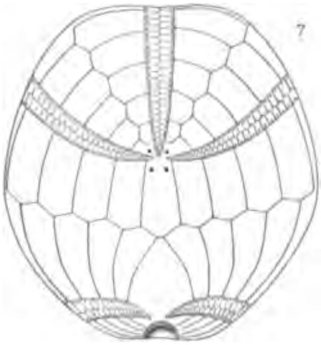


DYSASTER RINGENS .. *Agassiz.*

VAR. EUDESII

BRITISH FOSSILS.

Decade III. Plate X.

MICRASTER COR-ANGUINUM.

[Genus MICRASTER. Agassiz. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Spatangaceæ.) Body cordate, tumid; dorsal ambulacra narrowly petaloid, not circumscribed by a peripetal band; dorsal surface studded with uniform small tubercles, no large primaries; anus terminal, supra-marginal; caudal (infra-anal) extremity circumscribed by a band.]

Diagnosis. ***M. ambitu cordato, dorso convexo, postice arcuato; ambulacris dorsalibus impressis, sulcis porarum terminalium vix decrescentibus; assulis arearum ambulacralium dorsalium tumidis, subtuberculatis.***

Forma α. *Normalis, regulariter cordatus, dorso vertice subcentrali; genis tumidis. Spatangus cor-anguinum a. anglicum*, Leske, ap. Klein, p. 28, tab. 23, A, B. *Echinus cor-anguinum*, Gmelin, 3195. *Spatangus cor-anguinum* and *punctatus. Ananchytes spatangus* and *semiglobosus*, Lamarck, An. sans Vert. iii., pp. 26 and 32. *Spatangus cor-anguinum*, Alex. Brongniart, Desc. Geol. des Env. de Paris, pl. 4, fig. 11. *Spatangus cor-marinum*, Parkinson, Org. Rem. iii., pl. 3, fig. 11. *Spatangus cor-anguinum*, Goldfuss, Pet. Germ., pl. 48, fig. 6; and *Spatangus cor-testudinarium*, ibid., pl. 48, fig. 5. *Micraster cor-anguinum*, Agassiz and Desor, Cat. Rais., in Ann. des Sc. Nat., 3rd series, tome viii., p. 23. *Micraster cor-testudinarium*, Bronn, Lethæa, pl. 29, fig. 23.

Forma β. *Rostratus, regulariter cordatus, dorso carinato, vertice in areâ anali, genis tumidis. Ananchytes cordata*, Lamarck, An. sans Vert. iii. *Spatangus rostratus*, Mantell, Geol. Suss., pl. 17, figs. 10, 12; Woodward, Geol. Norf., pl. 5, fig. 7. *Micraster cordatus*, Agassiz, Cat. Syst., 2; and Cat. Rais. des Ech., p. 23.

Forma γ. *Gibbus, late cordatus, dorso vertice centrali, postice anticeque declivente, genis compressis.*

Var. *a. pyramidata. Spatangus gibbus*, Lamarck, Anim. sans Vert. iii., fig. in Ench. Meth., pl. 156, figs. 4-6. *Micraster gibbus*, Agassiz and Desor, Cat. Rais. des Echin. Ann. des Sc. Nat., 3rd ser., tome viii., p. 24; Forbes, in Dixon's Sussex, p. 342, pl. 24, fig. 314.

VAR. *b. tumidior.* *Spatangus gibbus*, GOLDFUSS, Pet. Germ., p. 156, pl. 48, fig. 4. *Spatangus cor-anguinum*, WOODWARD, Geol. Norf., pl. 5, fig. 8. *Micraster gibbus*, AGASSIZ, Cat. Syst., p. 2; E. SISMONDA, Mem. Ech. Foss. Nizza, p. 23. *Micraster brevis*, DESOR, Cat. Rais. des Echin. Ann. des Sc. Nat., 3rd ser., tom. viii., p. 24.

The first illustration of the genus MICRASTER selected for these Decades is one of our commonest cretaceous Echinidæ. It is chosen partly because the perfection and abundance of specimens permit of its structure being described and delineated more in detail than that of any of its congeners, and partly since, common as it is, nevertheless, like most common fossils, it requires a much more critical examination than it has yet undergone.

It has been figured and described, according to their fashion, by many of the older writers on fossils. Llhwyd, Hook, Breyn, Schlotheim, Walch, Morton, Klein, Davila, Van Phelsum, and Leske have severally represented and commented upon it. Very variable in its features, unless we have many specimens before us, we can scarcely put two or three examples together which are closely alike in proportions. This capacity for variation has caused many spurious species to be constructed out of one.

It is the type of the genus *Micraster* of Agassiz. That genus is distinguished among the other Spatangaceæ with petaloid ambulacra, from *Spatangus* and its allies, by its surface being covered with secondary tubercles only, and by its rather narrow ambulacra, not bounded by or including a fasciole of tertiary spines; by the presence of a sub-anal fasciole from *Brissus* and *Amphidetus*.

The outline of the body is always cordate, in most specimens nearly as broad on the widest part as long, sometimes broader than long—rarely much longer than broad. The greatest width of the lateral outline is invariably a little behind the antero-lateral ambulacral plates; from that point to the anal extremity it describes a regular and considerable curve in all the varieties. The dorsal surface varies from an almost conical convexity (extreme form of *Spatangus gibbus*, Lamarck) to depressed, as seen in the larger variety of the typical *cor-anguinum.* When very conical and compressed, then the highest part, or vertex, is at the apex, or ovarian, disk of the shell; in the depressed form it is a little behind this disk; in the rostrated form it is behind this disk, nearly in the centre of the posterior interambulacral area. The anterior half of the back varies in degree of declivity in all the forms, but is especially steep in the extreme form of *gibbus*, and in a not uncommon variation of *rostratus.* Intermediate specimens, exhibiting every degree of tumidity of the cheeks (or swelling on each side of the odd ambulacrum) are common. As a general rule, the cheeks are tumid. The posterior half of the back varies greatly in declivity in the several varieties; the posterior interambulacral space declining in one set of forms, becoming elevated in another; the former being the *gibbus* of Lamarck and the variety figured under the same name by Goldfuss, the latter being the *rostratus* of Mantell, *cordatus* of Lamarck. But whether declining or elevated, the outline of the posterior interambulacral space is always an arcuated curve. According to its elevation, so is the altitude of the anus on the truncated posterior extremity. This aperture is circular, occupying a depression bounded by a narrow and defined circle of smooth-edged plates. The surface below it is flattened or slightly hollowed out, the bounds of the depression corresponding to two terminal bosses or caudal projections, which in the living animal doubtless bore two projecting tufts of long spines. These caudal projections are included within the sub-anal circumscribed space; the circumscription (which in specimens of this species is not always conspicuously manifest) is transversely oblong and inclined to quadrate. The ventral surface is slightly tumid, but sometimes nearly flat centrally. The mouth is placed very near the anterior extremity, at the inferior termination of the deeply impressed anterior ambulacrum. It varies slightly in position in different specimens. Its projecting lip is strong and thickened, and varies in degree of projection.

The dorsal ambulacra, or rather stellate portions of them, are through a great part of the length of them parallel-sided, not contracting much towards their lower extremities, so that their form is oblong-lanceolate, and but slightly petaloid. They are all, throughout the greater part of their length, placed in depressions of different degrees of depth in different examples; sometimes very shallow, and the ambulacra almost on a level with the surface, especially in young specimens. The anterior or odd one is very variable in its degree of development, and differs from the others—its ambulacral area simply granulated, without tumidity of the separate plates: in many examples the grooves connecting its pores are obsolete. The lateral ambulacra vary greatly in length in different specimens and varieties: the antero-laterals are always longer than the postero-laterals, sometimes considerably so. The latter are longest in the conical forms of the species, but the relative length of these ambulacra cannot be taken as a specific character, nor can the number of the pairs of pores in them, seeing that almost every specimen varies in this respect, as may be seen by comparing the enumeration in the table given hereafter. The lateral ambulacra, however, in other points exhibit excellent characters, constant throughout all the individuals of every variety of the species. Their ambulacral plates are invariably tumid, rugose, and separated by a strongly marked suture, whilst the general suture running down the centre of the ambulacral area is deeply depressed and groove-like. The ridge separating each poriferous groove is also tumid and studded with a single row of conspicuous close-set tubercles, usually five or six in each series.

The genital disk is composed of four developed genital plates, each with an oviducal hole. The posteal or fifth plate is undeveloped. The left antero-lateral is much larger than the others; in its upper portion, which occupies the centre of the disk, it is minutely punctated, forming the madreporiform body. The eye-plates are all five developed and perforated.

The whole of the dorsal and lateral plates are minutely granulated and studded in a scattered manner with small, nearly equal spiniferous tubercles, each consisting of a perforated tubercle placed on a crenulated base, and surrounded by a smooth ring. They become much more closely set on the lower parts of the side, and are much larger on the ventral surface of the body, and regularly arranged on the ovate, acute post-oral spinous space, but are few on the ambulacral plates bounding that area. The ambulacral pores radiating from the mouth are lodged in short inconspicuous rather rugose grooves. The sutures of the plates below and near the anus are edged with minute granules arranged in rows.

The spines are rarely seen, and have never before been represented, nor, I believe, described. They are very slender and small; not, however, all minute, for some are as much as a quarter of an inch in length, and were possibly longer. They are mostly arcuated near the base, ridged along their length by about six ribs, which in some specimens appear to be rugose with prickle-like projections apparently arranged spirally, thickened suddenly at their bases, where they are surrounded by a strongly crenulated ring. The habits of the animal, as indicated by these spines, probably resembled those of the existing sea-urchins of the genus *Brissus.*

Very young specimens are mostly of a more elongated form than is seen, except rarely, in the adult; but there are also tumid young ones, and it is possible that the sub-depressed and tumid forms of this species (*cor-anguinum* and *rostratus*), both of which are common and found together, may be male and female individuals respectively.

Flint-casts of the interior of this urchin are not uncommon, and when in fine condition serve beautifully to illustrate the arrangement of the plates. The anterior and lateral interambulacral segments of the body, although very unlike, are formed of about twelve pairs of plates in each compartment. Those of the anterior segment gradually increase in dimensions as they approach the wider and lower portion of the cheeks; those of the lateral compartments are unsymmetrically unequal, and the lower or ventral ones assume irregular polygonal shapes with increased size, in order to fill up the triangular sides of the oral surface. The odd or posterior interambulacral area has the plates considerably distorted by the position of the vent. Those above it increase gradually, and are about six or seven in number. From four to six bound the sides and the lower margin of the vent, and three pair fill up the sub-anal region as far below as the base of the post-oral spinous space, which is composed of a pair of large triangular plates with curved outer sides. The number and arrangement of the interambulacral plates does not seem to differ much in any of the varieties, but the number of the ambulacrals differs in every specimen which is not exactly similar to some other. In a cast of the form *cor-testudinarium* the number of pairs of pores in the anterior ambulacrum was (petaloid region) 12 + (plane region) 15; in the antero-laterals (petaloid region) 25 + (plane region) 15; in the postero-laterals 19 + (plane region) 16 + (ventral region) 5. In a cast of the *gibbus* form, the respective numbers ranged in the same order were—

Anterior ambulacrum . .	22 + 12
Antero-lateral ditto . . .	35 + 19
Postero-lateral ditto . . .	30 + 17 + 5.

Flint-casts often show very clearly the arangement of the oviducal pores and eyes. The number of pairs of pores increases with age.

In the following table I have contrasted the dimensions and numbers of pair of pores in the dorsal ambulacra of twelve adult specimens taken from among all the chief varieties. It will be seen that these characters are very variable, and not sufficient to warrant specific distinction.

Variety, and Number of Specimen in Survey Collection.	Length.	Breadth.	Height.	Number of Pores in a row in each Antero-lateral Avenue.	Number of Pores in a row in each Postero-lateral Avenue.	Number of Pores in a row in the Anterior Ambulacrum.
	Inches.	Inches.	Inches.			
1. γ. Extreme form, "Gibbus" of Lamarck .	3	3	3	46	37	28
2. γ. Extreme but small form	$2\frac{4}{12}$	$2\frac{4}{12}$	$1\frac{1}{2}$	43	30	22
3. γ. Ditto	$1\frac{11}{12}$	2	$1\frac{7}{12}$	36	34	25
4. γ. "Gibbus" of Goldfuss	$1\frac{1}{12}$	$2\frac{1}{12}$	$1\frac{1}{2}$	36	31	. .
5. γ. Ditto	$1\frac{7}{12}$	$1\frac{9}{12}$	$1\frac{3}{12}$	33	25	18
6. Inter γ and β, nearer γ .	2	$2\frac{1}{12}$	$1\frac{1}{2}$	31	21	19
7. Inter α and γ . . .	$1\frac{11}{12}$	2	$1\frac{3}{12}$	29	21	20
8. α. Tumid form . . .	2	2	$1\frac{4}{12}$	27	22	20
9. α. Depressed	$2\frac{5}{12}$	$2\frac{4}{12}$	$1\frac{3}{12}$	32	28	20
10. α. Ditto	$2\frac{2}{12}$	$2\frac{2}{12}$	$1\frac{3}{12}$	34	24	20
11. β. Rostrated	$2\frac{2}{12}$	$2\frac{3}{12}$	$1\frac{1}{2}$	34	25	18
12. β. Ditto	2	2	$1\frac{4}{12}$	31	22	22

The very great variation of outline, tumidity, and consequent arrangement of the ambulacra, have caused this *Micraster* to be split up into numerous spurious species. But in the collections of the Geological Survey, and in many private collections, especially those of Mr. Bowerbank and Mr. Wetherell, where extensive suites of specimens are assembled, and intermediate forms as carefully preserved as extreme ones, it becomes very manifest that all resolve themselves into one species, sufficiently marked by constant characters common to all the individuals. I have grouped them under three conspicuous types—*normalis, rostratus,* and *gibbus;* but as the variations of each of these have been honoured by not a few palæontologists with specific rank, I think it best to enumerate all the forms which have been so distinguished.

A. "*Species*" *constructed out of the Normal form.*

1. *Cor-anguinum,* Auctorum. The old figures in Leske's edition of Klein (tab. xxiii., figs. A, B, C, D), are bad representations of the ordinary aspect of what is placed in collections under this name. The figure of *cor-anguinum,* Goldfuss (Pet. Germ., tab. xlviii., fig. 6), is perhaps the best representation of one of the most common varieties of what is regarded as this species by all authors. Parkinson's *Spatangus cor-marinum* (Org. Rem., iii., pl. 3, fig. 11), represents a specimen with deeper ambulacra than usual. The *cor-anguinum* of Woodward's "Geology of Norfolk" is var. *gibbus.*

2. *Spatangus cor-testudinarium.* Goldfuss (tab. xlviii., fig. 5); *Micraster cor-testudinarium* of Agassiz (Cat. Syst.); but more lately (in the Catalogue Raisonné) considered by Agassiz and Desor as "var. *lata*" of their restricted *Micraster cor-anguinum.* This is only a very slight variety of the normal form, constructed out of such specimens as have the mouth slightly further back than usual, a feature not unfrequently seen in depressed specimens. According to Agassiz, the name "*Spatangus anticus*" of Defrance applies to this form.

3. *Micraster arenatus* of Agassiz (Cat. Syst.), since referred by Agassiz and Desor to their variety "*major*" of their *cor-anguinum,* to which variety they refer the figure and description of "*Micraster arenatus,*" in E. Sismonda's "Memoria sugli Echinidi Fossili del contrado di Nizza" (p. 28, tab. i., fig. 2). In the plate in question, however, no profile of this urchin is given, and the description of the elevation of the back, would seem rather to indicate a variety of the *gibbus* or *rostratus* types. F. A. Roemer, in his "Versteinerungen des Norddeutschen Kreidegebirges," identifies *arenatus* with "*rostratus.*"

4. *Micraster Michelini* of Agassiz (in the Catalogue Raisonnée). This is the *cor-anguinum* of Agassiz, in his "Description des Echinodermes Fossiles de la Suisse" (tab. iii., figs. 14, 15); in which work he identifies it with the *cor-anguinum* of previous authors. In his later

catalogue he remarks on it—" Forme intermediaire entre le *M. cor-anguinum* et le *M. acutus.* Les ambulacraires sont dans des sillons plus profonds et plus larges." His figure is a very good representation of a very ordinary and normal specimen of *cor-anguinum.* Sismonda has cited it also as such without, any more than myself, seeing peculiarities in it.

5. *Spatangus punctatus*, Lamarck. The figure (tab. xvii.* c.) of Leske, referred to as representing this species, is an ordinary but large specimen of the normal form; and we are assured by Agassiz (Echin. Suisse, i. p. 25) that his examination of Lamarck's original specimens convinced him that this, and

6. *Ananchytes semiglobosus*, Lamarck, and

7. *Ananchytes spatangus*, Lamarck, are all specimens of *cor-anguinum.* The true structure of *Ananchytes*, as contrasted with *Spatangus* and *Micraster*, was not understood by Lamarck, whose examination of the Echinidæ generally is extremely superficial.

8. *Spatangus acutus*, Deshayes (Coq. Caract. des Terr., tab. xi., figs. 5 and 6), is regarded by Agassiz and Desor as a distinct species. Judging from the figure, it appears to be a specimen of the normal form of *cor-anguinum*, in which the caudal extremity is slightly more produced than usual, a variation not uncommon.

B. " *Species*" *constructed out of the Rostrated form.*

9. *Ananchytes cordatus*, Lamarck. *Micraster cordatus*, Agassiz and Desor. Regarded as distinct also by E. Sismondi. Identical with this is

10. *Spatangus rostratus*, Mantell; and, according to Agassiz and Desor,

11. *Spatangus Requieni*,

12. *Scutella pyramidalis*, Risso; and

13. *Spatangus bituricensis*, Defrance.

C. " *Species* " *constructed out of the Gibbous form.*

14. *Spatangus gibbus*, Lamarck. *Micraster gibbus* of Agassiz and Desor, but not of the Catalogue Systématique. The figures in the Encyclopèdie Méthodique (pl. clvi., figs. 4, 5, 6) represent this pseudo-species, which, however, has a far more specific aspect than any of the other varieties. Such extreme examples occasionally occur in England, but are rare. The great development of the postero-lateral ambulacra, resulting from the great elevation of the apex and the low position of the vent, seems, at first, a sufficient distinction, but this character varies much, passes distinctly into the variety next to be named, and through it into more normal types.

15. *Micraster brevis*, Desor; the *Spatangus gibbus* of Goldfuss, *Micraster gibbus* of Agassiz (Cat. Syst.) The intermediate form between No. 14, and more ordinary varieties. It is not uncommon in England,

and graduates very gently into 14 on the one side, and the normal *cor-anguinum* on the other.

Agassiz and Desor (whose declaration that forms are specifically identical is pretty good warrant for considering them undistinguishable) identify with this form

16. *Spatangus ananchytoides*, Desmoulin, and, 17, *Micraster latus*, Agassiz (Cat. Syst.) and Sismonda, whose figure represents the specimen only from above. It is fair to say that the Italian author, in the "Memoir on the Fossil Urchins of Nice," distinguishes his *latus* from *gibbus*, referring the latter name to both Lamarck and Goldfuss. He inserts Risso's *Spatangus sub-alpinus* as a doubtful synonym of *latus*. From the view which Sismonda, in the very excellent memoir cited, one of the best papers on fossil Echinoderms with which I am acquainted, takes of the specific distinctions of *Micrasters*, in all probability his *latus* should claim only to rank as a sub-variety under the form *gibbus* of *cor-anguinum*.

Thus seventeen forms, at fewest,—I fear more might be added,—have been at different times regarded as distinct species; all of which appear to be variations (many not even so much) of a single specific type. In the "Catalogue Raisonné des Echinides" the authors hold out of the number, six specific types of *Micraster*, viz., *cor-anguinum*, *Michelini*, *acutus*, *cordatus*, *brevis*, and *gibbus*. But how *acutus* and *Michelini* are to be separated from *cor-anguinum* it is difficult to understand; whilst that *cordatus* (better known in England under the name of *rostratus*) is a variety of *cor-anguinum*. few collectors even will be inclined to dispute. As to the form called *brevis*, it is constantly regarded in England as a variety of *cor-anguinum*, and most certainly, as I have already said, passes into the normal type on the one hand, and into the extreme *gibbus* on the other, by almost imperceptible gradations.

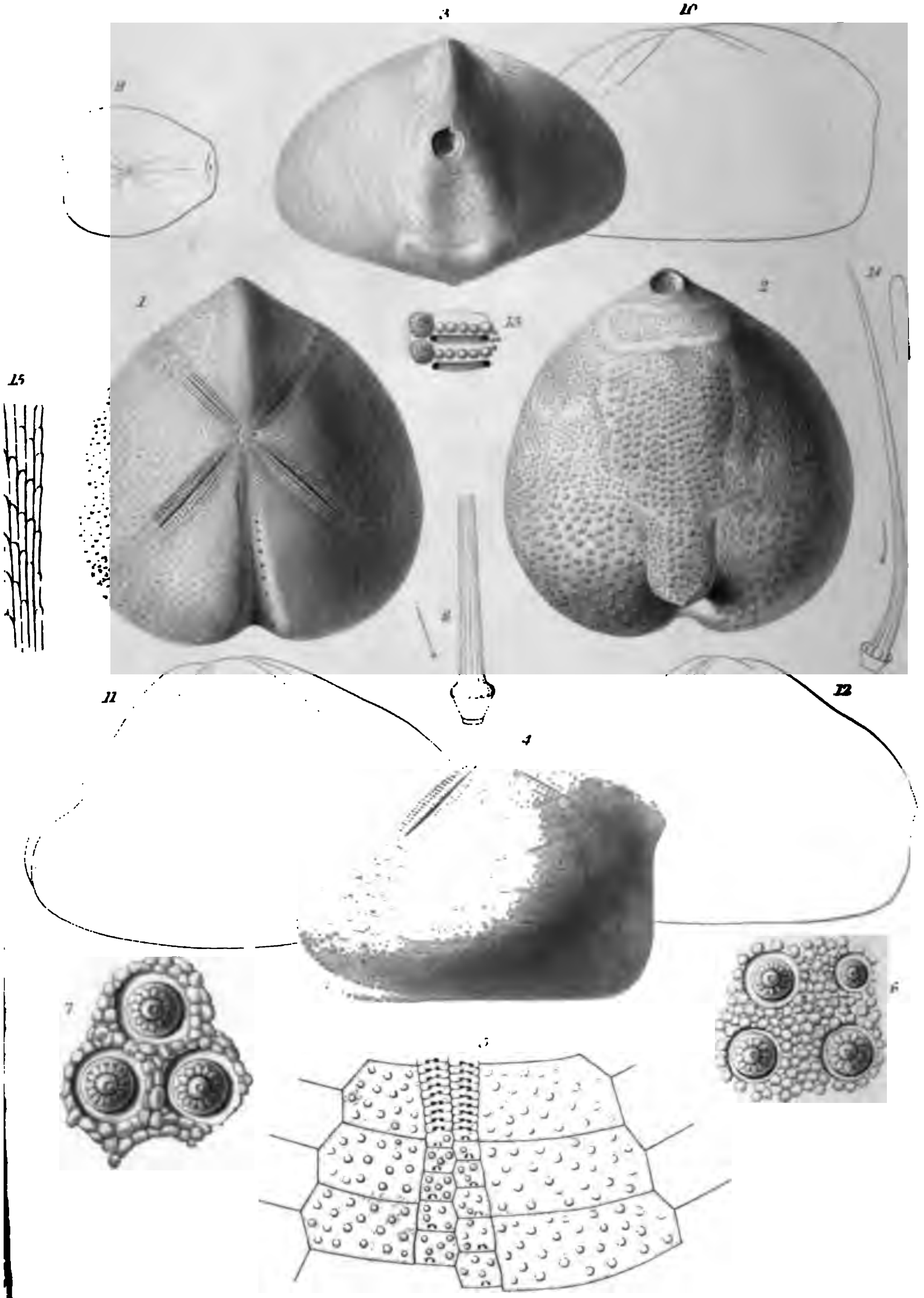
British Localities and Geological Range.—CHALK. It is found in all the chalk districts of England; abundantly in many counties, as in Kent, Sussex, and Norfolk. Its geological position is usually in the upper chalk; it is recorded also from the lower chalk of Pinhay and Charlton. The normal and rostrated forms are most common; the sub-gibbous variety is next, and the extreme gibbous one rarest. Portlock records it from the chalk of Magilligan, county Derry, in Ireland.

It is said to occur in the green-sand of Devon, but this is probably a mistake.

Foreign Distribution.—In the chalk of France, Germany, Switzerland. Sismonda finds it in the marly chalk in the neighbourhood of Nice. Agassiz records the sub-gibbous variety from the chalk marl of Normandy, &c.; from the "Craie chloritée of Coudrecieux (Sarthe);" and from the chalk with Hippurites of Nice.

Geological Survey of the United Kingdom.

MICRASTER
(Cretaceous)



MICRASTER COR-ANGUINUM. _Gmelin.

J.W. Lowry

Description of the Plate.

Fig. 1. Specimen of the form β seen from above.

Fig. 2. The same from below.

Fig. 3. The same, posterior view.

Fig. 4. The same, lateral view.

Fig. 5. Ambulacral and interambulacral plates, showing the termination of the dorsal petals of one of the lateral ambulacra.

Fig. 6. Spiniferous tubercles of dorsal interambulacral plates.

Fig. 7. Ditto of ventral plates.

Fig. 8. Base of one of the straight spines, greatly magnified.

Fig. 9. Outline of a young specimen of the elongated form (in Mr. Bowerbank's collection.)

Fig. 10. Outline profile of the normal form.

Fig. 11. Outline profile of the gibbous form (in Mr. Bowerbank's collection.)

Fig. 12. Ditto of the sub-gibbous form.

Fig. 13. Granulation and tumidity of the ambulacral plates of the petaloid portion of the dorsal ambulacra (highly magnified). This is the distinctive character of the species.

Fig. 14. A spine from near the anal region, figured from a specimen in Mr. Bowerbank's collection: the spatulate extremity is shown by its side.

Fig. 15. A portion of a spine, exhibiting a spirally rugose structure.

Note on Allied British Species.

Mr. Morris, in his valuable "Catalogue of British Fossils" (1843), enumerates ten species of *Micraster*. Since the publication of that work the Brissoid species of the group, as then received, have been separated very properly by Agassiz. Only four of the names there given, consequently, fall strictly under *Micraster;* viz., *cor-anguinum*, *cor-testudinarium*, *gibbus* (for which both Lamarck and Goldfuss are cited), and *rostratus*. All of them are here regarded as varieties of one species, viz., *Micraster cor-anguinum*.

There is, however, a *Micraster* found in our British chalk, which is very distinct from *cor-anguinum*, and which does not appear to belong to any of the *described* species of foreign authors. I have given an account of it in Mr. Dixon's work on the Geology of Sussex, where it is excellently figured. I have there named it *Micraster cor-bovis*. It is usually a larger and longer species than *cor-anguinum*, and its petaloid ambulacra are more deeply impressed and much shorter in proportion to the body. The shape is ovato-cordate, the curve of the sides from the front of the antero-lateral ambulacra to the anal extremity being but slight, its chief swelling being near the anus, and not on a line with the end of the postero-lateral ambulacra, as in *cor-anguinum*. The back is more equally depressed than in the depressed variety of the last-named species. The mouth is much smaller comparatively, and the post-oral spinous space, though much longer, in consequence of the elongation of the hinder portion of the test, is nevertheless proportionally broader. The tubercles of the plates, whether dorsal or ventral, are much smaller and more scattered. Besides all these comparative characters, there is the positive one that in *cor-bovis* the ambulacral plates, instead of being tumid are smooth and plane, as are also the ridges separating the sulcations of the pairs of pores in the petaloid ambulacra. The ambulacral spaces are wider than the breadth of any of the sulcations. As contrasted with *Cor-anguinum*, the diagnosis of *cor-bovis* would stand thus:—

M. ambitu ovato-cordato, dorso convexiusculo, postice leviter arcuato, elongato; ambulacris dorsalibus impressis, assulis arearum ambulacralium dorsalium planis, lævigatis.

I have seen specimens of this species, which attain a length of 3 inches by 2⅓ at its broadest part, and a height of 1 inch $\frac{8}{12}$, in the collection of the lamented Mr. Dixon of Worthing, who had it from Sussex; in Mr. Bowerbank's collection; and in the Museum of the Geological Society, where there are specimens from Charing, Kent, presented by Mr. W. Harris, and from Hemel Hempstead, presented by Mr. H. C. White.

In Mr. Bowerbank's collection there are specimens, unfortunately not in sufficiently good condition, of a small *Micraster*, with a very elevated extremity, from the lower chalk of Lyme, which is possibly a distinct species.

EDWARD FORBES.

June, 1850.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE IV.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

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BRITISH FOSSILS.

DECADE THE FOURTH.

ALL the plates and descriptions in this Decade are devoted to fossil Echinodermata of the order *Echinoidea.*

The genera selected for illustration are *Temnechinus*, *Acrosalenia*, *Hyboclypus*, *Hemipneustes*, *Ananchytes* with its section *Holaster*, and *Cardiaster*. The geological age of the first is Upper Tertiary, of the second and third Oolitic, of the remainder Cretaceous. Several of the species are represented for the first time.

Temnechinus is a genus remarkable for its species being at present known only as fossils of the Coralline and Red Crags; it is now characterized for the first time.

The examples of *Acrosalenia* selected are both remarkable for their beauty and their very perfect condition. They are also of much interest, one on account of the rectification of its true generic position, which I have been enabled to make through the aid afforded by very perfect specimens: the other, because of the complete preservation exhibited by the specimens described of parts too often lost in fossil Echinoderms. I have appended to the descriptions of these *Acrosaleniæ* brief characters of some new species of this interesting oolitic genus.

Hyboclypus is illustrated by the finest and largest species of the genus, one discovered during the researches of the Geological Surveyors.

Hemipneustes, to which genus I unite *Toxaster*, is now for the first time authentically represented by a British example, remarkable for its novelty and for the light it throws upon the mutual affinities of those genera of *Echinoidea* which have excentric mouths.

The well known genus *Ananchytes* is combined (as indeed it was formerly by Lamarck) with *Holaster*. In selecting the common *Ananchytes ovata* of the Chalk for the subject of a plate and description, I have been influenced by the necessity of clearing up the confused synonymy of this fine fossil, and of settling the numerous spurious species which have been constituted out of its varieties, or from imperfect figures contained in old works.

Cardiaster is a new genus, lately constituted by myself for some remarkable and interesting sea-urchins, intermediate in their characters between *Ananchytes* and the true *Spatangidæ*. To the account of the species figured I have added notices of all the forms of this curious type which are known to me as British.

EDWARD FORBES.

October, 1852.

BRITISH FOSSILS.

DECADE IV. PLATE I.

TEMNECHINUS EXCAVATUS.

[Genus TEMNECHINUS. FORBES (1852). (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Echinidæ.) Body spheroidal; ambulacral and interambulacral segments developed, bearing on their plates, whose sutural margins are excavated but not perforated on the dorsal surface of the test, tubercles of various sizes, imperforate and placed on smooth bosses. Vent in the centre of the prominent apical disk, which is composed of five genital and five ocular plates, all perforated. Ambulacral avenues composed of pairs of pores indistinctly ranked; the ranks confluent throughout. Mouth central, inferior, armed with a powerful dental lantern. Spines of one order, but of various sizes.]

SYNONYMS. *Temnopleurus excavatus*, SEARLES WOOD, in Morris Cat. Brit. Foss. p. 60. (1843.)

Temnopleurus Woodii, AGASSIZ, Cat. Rais. des Echin. in Ann. Sc. Nat. 3d series, t. vi. p. 360. (1846.) *Temnechinus excavatus*, FORBES, Brit. Tert. Echin. p. 6, pl. 1, fig. 1. [published by the Palæontog. Soc.] (1852.)

DIAGNOSIS. *T. corpore depresso, superne subexcavato, sulcis suturalibus profundis confluentibus.*

It is very remarkable that a group of Echinidæ differing essentially and generically from any known assemblage should be characteristic of the Coralline and Red Crag formations of England, and at present be known only as confined to them. The type of this genus is the form here described. I have named the group TEMNECHINUS (*τεμνος*, *incisus*, and *εχινος*).

This beautiful Echinite was originally named by Mr. Searles Wood and placed by Professor Agassiz in his genus *Temnopleurus*, under which it was enumerated by Mr. Morris in his catalogue. But *Temnopleurus* has imperforated tubercles elevated upon crenulated bosses, a striking and easily recognized character, shared also by *Salmacis*. *Temnechinus* accordingly will hold a position intermediate between these genera and *Echinus* strictly so termed. In the arrangements of its genital disk it exhibits considerable peculiarities of its own. Its spines resemble more nearly those of

Echinus than those of the other genera just mentioned. In the disposition of the pores of the ambulacral avenues it approaches *Temnopleurus* rather than *Echinus* or *Salmacis*.

No *Echinidæ* with excavated sutures are now known to exist in the European seas or in the temperate and colder portions of the North Atlantic; they are all inhabitants of tropical seas, and especially of the Indo-Pacific province. The fact of a group of these sea-urchins having inhabited the British area during the epoch of the deposition of the Crags would seem to indicate some ancient relation between that region and seas to the south-east, probably communicating with the Indo-Pacific.

The body of *Temnechinus excavatus* is of a depressed melon shape. The ambulacra are a little more than half as broad as the interambulacra. The former are composed of about 32 plates, 16 in each series. The three uppermost of these plates are deeply excavated on their inner sides, and bear granules but no tubercles on their more convex portions. The remainder bear each a primary tubercle on the outer margin. They are all excavated more or less on their inner sides, the excavations of the four or five upper ones becoming confluent, those of the remainder forming distinct alternating oblong pits, which become smaller and smaller until they are nearly obsolete in the neighbourhood of the mouth. The elevated interstices form a ziczac ridge, the outer angles of which join the bases of the primary tubercles; on this ridge are minute secondary tubercles and granules. The plates of each interambulacral segment are about 20, ten forming each vertical series. The two uppermost joining the genital disk are smooth or nearly so; the remainder bear each a primary tubercle not larger than those of the ambulacra. The four plates next after the uppermost in each row are tumid on their outer halves, very deeply and steeply excavated on their inner sides. On the inner sides of the tumid portions are the primary tubercles surrounded by secondary tubercles and granules. Their excavations combined form a deep ziczac trench, smooth at the base. The remainder of the plates are similarly ornamented with tubercles and granules; the sutural indentations, however, are not confluent, but form deep loop-shaped smooth pits, becoming very small near the mouth. The lines of division between plates run through the pits. The avenues of pores are deep-set, and are composed of pairs of pores separated by fine ridges and ranged in single file, the rows being undulated. There are about 50 pairs of pores in each row.

When the test is looked upon from above, the deep wavy furrows are those of the interambulacral sutures. Below, the indentations are so slight that the surface at first glance resembles that of a *Salmacis*.

The mouth is less than one third of the diameter of the test, and one fourth wider than the breadth of the genital disk. It is very obscurely ten-notched. The ambulacral arches are seen within it, large, complete, and set obliquely.

The apical disk is composed of five perforated genital and five perforated ocular plates surrounding the vent. The genital plates are nearly equal, very elevated and prominent, with steep, smooth, slightly excavated sides and triangular summits covered with minute secondary tubercles (innermost) and granules. The madreporiform body is small and combined with the usual plate, the contour of which it scarcely disturbs. The genital pores are placed in the lowest and outermost portion, the smooth triangular projection in front of the base of each plate. The eye plates are large, pentagonal, and smooth, except a large obscurely defined gibbosity or rudimentary tubercle rising on their centres immediately above the eye-perforation, which is situated at their outer margins.

The primary spines are rather short and stout, with strong articular bases. They are sulcated by about ten strong furrows; the intermediate ridges are broader than the furrows and as if crenulated. The secondary spines appear to have been similar but more slender and delicate.

A fine specimen measures $\frac{11}{12}$ths of an inch in breadth by $\frac{5}{12}$ths of an inch in height. Examples vary in their proportions. The sulci are as strongly marked in an example little more than half that size as in the large one.

In some of the earlier lists of Crag fossils a *Cidaris* is mentioned. This *Temnechinus* was probably the sea-urchin intended.

Locality and Geological Position. Coralline Crag of Ramsholt in Suffolk. I owe to Mr. Searles Wood, Mr. Charlesworth, Dr. Clarke of Ipswich, and Mr. Bowerbank, the opportunity of examining most of the specimens that have ever been found. A fine example is contained in the Museum of Practical Geology, to which it was presented by Mr. Searles Wood.

EXPLANATION OF PLATE I.

Fig. 1. Upper side of *Temnechinus excavatus*, showing the deep and conspicuous inter-ambulacral sulcations.

Fig. 2. Under side.

Fig. 3. Side view of the same specimen.

Fig. 4. The apical disk seen from above and magnified.

Fig. 5. The same seen laterally, showing the steep sides of the genital plates, and the intermediate eye plates.

Fig. 6. Ambulacral and interambulacral plates, taken from the sides just below the confluent sulci.

Fig. 7. Similar plates, taken from the neighbourhood of the mouth.

Fig. 8. An [illegible] ambulacral arch.

Fig. 9. A spine highly magnified.

Notes on the species of TEMNECHINUS.

I have met with four species of this genus, all of which are described in my "Monograph of British Tertiary Echinoderms," contained in the publications of the Palæontological Society. These are

1. *Temnechinus turbinatus.* Forbes.
   From the Red Crag of Sutton.
2. *Temnechinus excavatus.* Wood.
3. *Temnechinus melocactus.* Forbes; and
4. *Temnechinus globosus.* Forbes.
   All three from the Coralline Crag.

EDWARD FORBES.

October, 1852.

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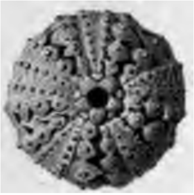

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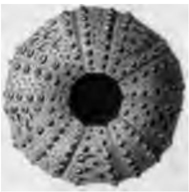

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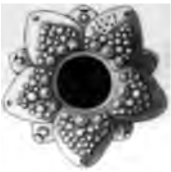

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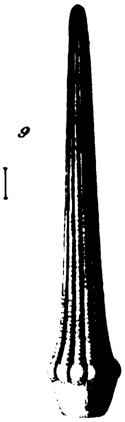

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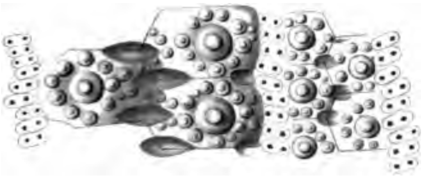

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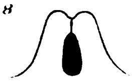

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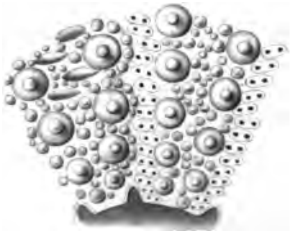

TEMNECHINUS EXCAVATUS *Wood*.

BRITISH FOSSILS.

DECADE IV. PLATE II.

ACROSALENIA HEMICIDAROIDES.

[Genus ACROSALENIA. AGASSIZ. (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Echinidæ.) Body spheroidal, usually depressed; ambulacral and interambulacral segments developed, the former bearing two rows of small secondary tubercles, the latter two rows of unequal large primaries; tubercles perforate, and placed on crenulated bosses. Anus excentric, included within the apical disk, which is formed of five genital and five ocular plates, with one or more supplementary central plates. Ambulacral avenues with the pairs of pores falling into single file above and on the sides, and becoming distinctly three-ranked near the mouth.]

REFERENCE. *Acrosalenia hemicidaroides.* WRIGHT, in Annals and Mag. of Nat. Hist., 2d ser. vol. viii. p. 161. pl. xi. fig. 1. (1851.)

DIAGNOSIS. *A. ambulacris angustis, tuberculis parvis approximatis alternatis ornatis; interambulacris tuberculis primariis conspicuis, ad latera magnis, superne parvis, areolis subconfluentibus; areâ centrali angustissimâ, granulatâ, granulis biseriatis.*

This, one of the most beautiful and best preserved of British Oolitic Sea-Urchins, has been for some years a well known ornament of collections, but received no specific appellation until it was described and figured in 1851 by Dr. Wright of Cheltenham, in his excellent memoir on the *Cidaridæ* of the Oolites.

The body is spheroidal, depressed above, usually considerably so, but not always. At first glance its most striking features are the large size and fewness of the interambulacral tubercles and their bosses, whilst those on the ambulacra are very small and but slightly spaced out. The interambulacral segments are centro-laterally thrice the breadth of the ambulacral ones, and are somewhat prominent. The latter are narrow, gently and gradually widening in the upper portion of their lower half, and exhibit a slightly undulating contour; they bear two rows of very small, nearly equal, and prominent secondary tubercles, each row consisting of (in large specimens) about 16, all of them perforated and placed upon bosses, each of which exhibits about 10 crenulations.

These ambulacral tubercles are separated from each other by narrow and irregular rows of granules, and are so arranged, in consequence of being closely set, that the tubercles of each row alternate. The ambulacral segments are each composed of two series of six or seven plates, each plate bearing a primary tubercle. The two plates nearest the mouth bear small ones; those of the sides very large ones, and those near the apical disk small ones. The tubercles are elevated on very prominent bosses (to the size of which their apparent dimension is chiefly due), around whose bases there is a broad smooth areola. The tubercles are perforate; the summits of the bosses crenulate; the number of crenulations ten or more. The areolæ are confluent, separated by a single line of minute granules. Alternations of minute secondary tubercles and small granules closely set form a narrow border to the ambulacral and interambulacral margins of each plate. Thus the medial region of each interambulacral segment becomes ornamented by a sinuous line of irregular secondary granules, two abreast, except above, where they become rather more numerous, until near the genital disk they become scattered or obsolete. Their number is slightly increased in the ambulacral margins of the interambulacral plates near the mouth. The mouth is wide, usually equalling in width the height of the test. Its margins are decagonal in consequence of ten deep notches with reflected edges that indent in pairs the buccal extremities of the interambulacral segments. The interspaces of these notches describe arches; those of the ambulacral segments being widest. The avenues of pores are very slightly sinuous; above, they are in strict single file; near the mouth they fall into two or three somewhat irregular curved ranks of three pairs in each. There is a small swelling or granule separating the pores of each pair.

The apical disk is wide and slightly convex; it occupies about a third of the diameter of the test. It is slightly pentagonal in consequence of the projection of the genital plates. These are large and escutcheon-shaped, except the posterior one, which is contracted in consequence of the excentric and posteal position of the vent, of which it forms one of the bounding plates. The genital orifices are placed not far from their outer margins. The right antero-lateral genital plate bears the madreporiform tubercle, indicated by a porous subcentral space. The eye plates are large, but the ocular pores are concealed in sub-marginal depressions. The centre of the disk is occupied by from four to six supra-anal plates, or it may be regarded as composed of one plate broken up into several elements. All the plates of the genital disk bear scattered granules.

The primary spines are variable in size in the same and in different specimens. They are shorter in young examples than in old ones. In some before us, the largest spines are three times as long as the diameter of the test. To the naked eye they seem smooth, but under the lens are seen to be obsoletely and finely striated longitudinally. They are more or less irregularly angular; the angles rounded; in section they are irregularly elliptical. They are broadest in their lower half, tapering upwards, and terminating in a single, bifid, or trifid extremity. The ring round their bases is narrow, elevated, and strongly crenulated. The neck is very short, and the margin of the articular socket is strongly crenulated also.

The secondary spines are very small, regular, round, and striated.

The dental-lantern is strongly developed, and often well preserved. It bears a close resemblance to that of *Echinus*.

The following table shows the comparative dimensions of three specimens selected on account of their differences:

	Elevated form.	Depressed form.	Ordinary small example.
Diameter of test -	1 inch.	$1\frac{1}{10}$ inch.	$0\frac{6}{10}$ inch.
Height of test -	$0\frac{5}{8}$ "	$0\frac{1}{2}$ "	$0\frac{4}{12}$ "
Diameter of mouth -	$0\frac{1}{2}$ "	$0\frac{1}{2}$ "	$0\frac{4}{12}$ "
Diameter of apical disk -	$0\frac{3}{8}$ "	$0\frac{4}{12}$ "	$0\frac{3}{10}$ "

The largest specimen in the Museum of Practical Geology measures one inch and one-twelfth in diameter, and has spines three inches and five-twelfths in length. The longest secondary spine upon it measures one-fourth of an inch.

Locality and Geological Position. The finest examples of this beautiful fossil were found by William Buy, an acute collector, in the Forest Marble near Malmesbury and Chippenham. We have it also from the same rock at Hinton Abbey, where it was collected by Mr. Pratt. Mr. Bristow has found a tumid variety of it in the Cornbrash near Wincanton. We have a group of specimens said to be from the Coral rag at Calne. Dr. Wright states that he has collected it in the upper beds of the Inferior Oolite at Leckhampton, and that the Rev. P. B. Brodie has found it in the same stratum at Selsley Hill; also that it is found in the Great Oolite at Minchinhampton, and at Kiddington in Oxfordshire.

EXPLANATION OF PLATE II.

Fig. 1. Body of the *Acrosalenia hemicidaroides* seen from above.
Fig. 2. The same seen from below, and showing the mouth.
Fig. 3. An elevated example, seen from the side.
Fig. 4. A specimen in which the dental lantern is preserved.
Fig. 5. Apical disk, with its constituent plates and posteal anus.
Fig. 6. Part of the ambulacral and interambulacral segments, taken from the side.
Fig. 7. Portions of the same segments from beneath, showing the three-ranked pairs of pores in the vicinity of the mouth.
Figs. 8. 9. and 10. Primary spines of the natural size.
Fig. 11. The base of one of the primary spines magnified.
Figs. 12. and 13. Sections of primary spines magnified.
Fig. 14. Plan of the base of a primary spine, showing the crenulations surrounding the socket and a second series above the neck.
Fig. 15. A secondary spine highly magnified.
Fig. 16. One of the interambulacral tubercles seen in profile, elevated on its crenulated boss, the sides of which are slightly excavated and the base surrounded by an areola.
Fig. 17. Portion of the dental apparatus.

EDWARD FORBES.

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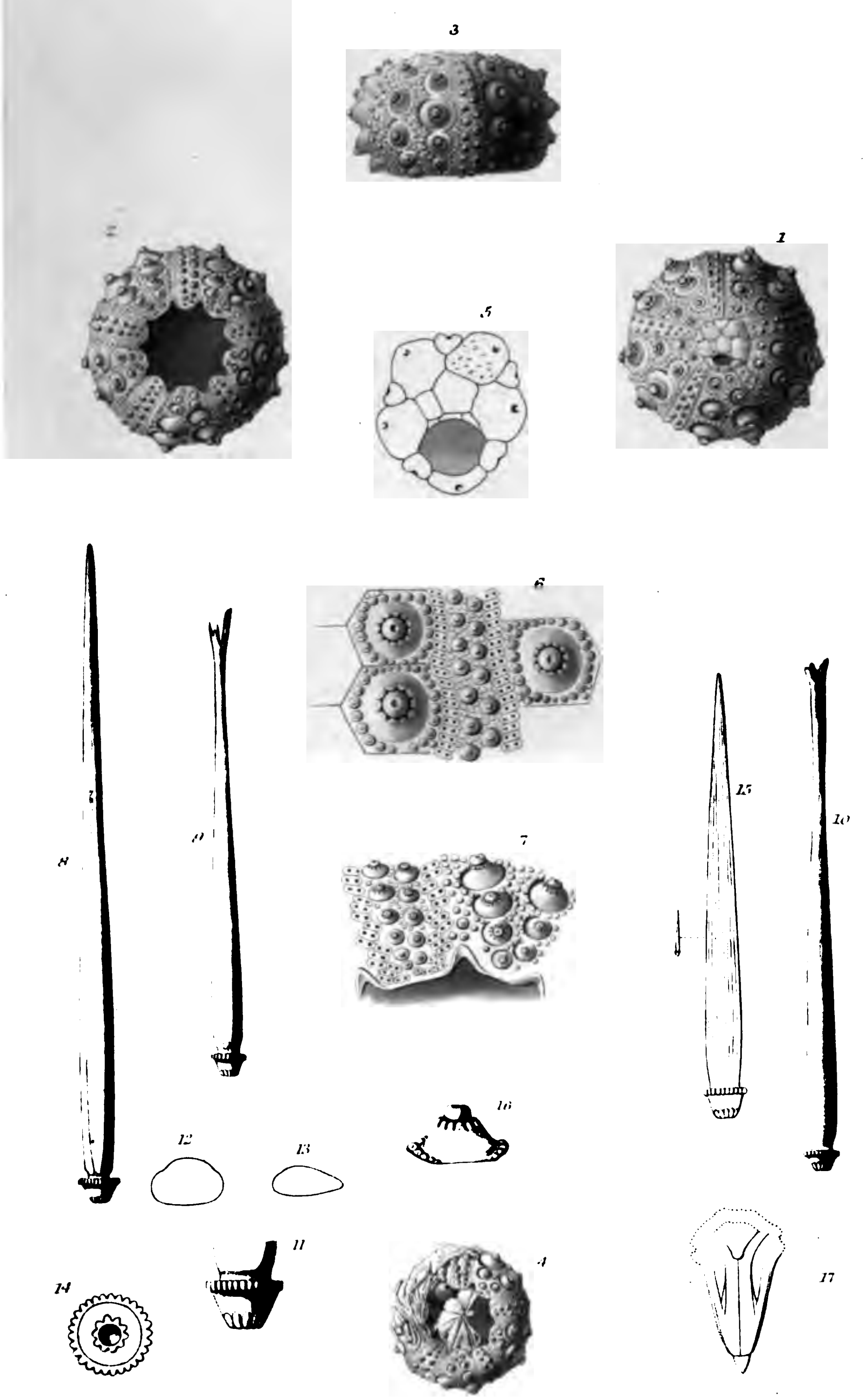
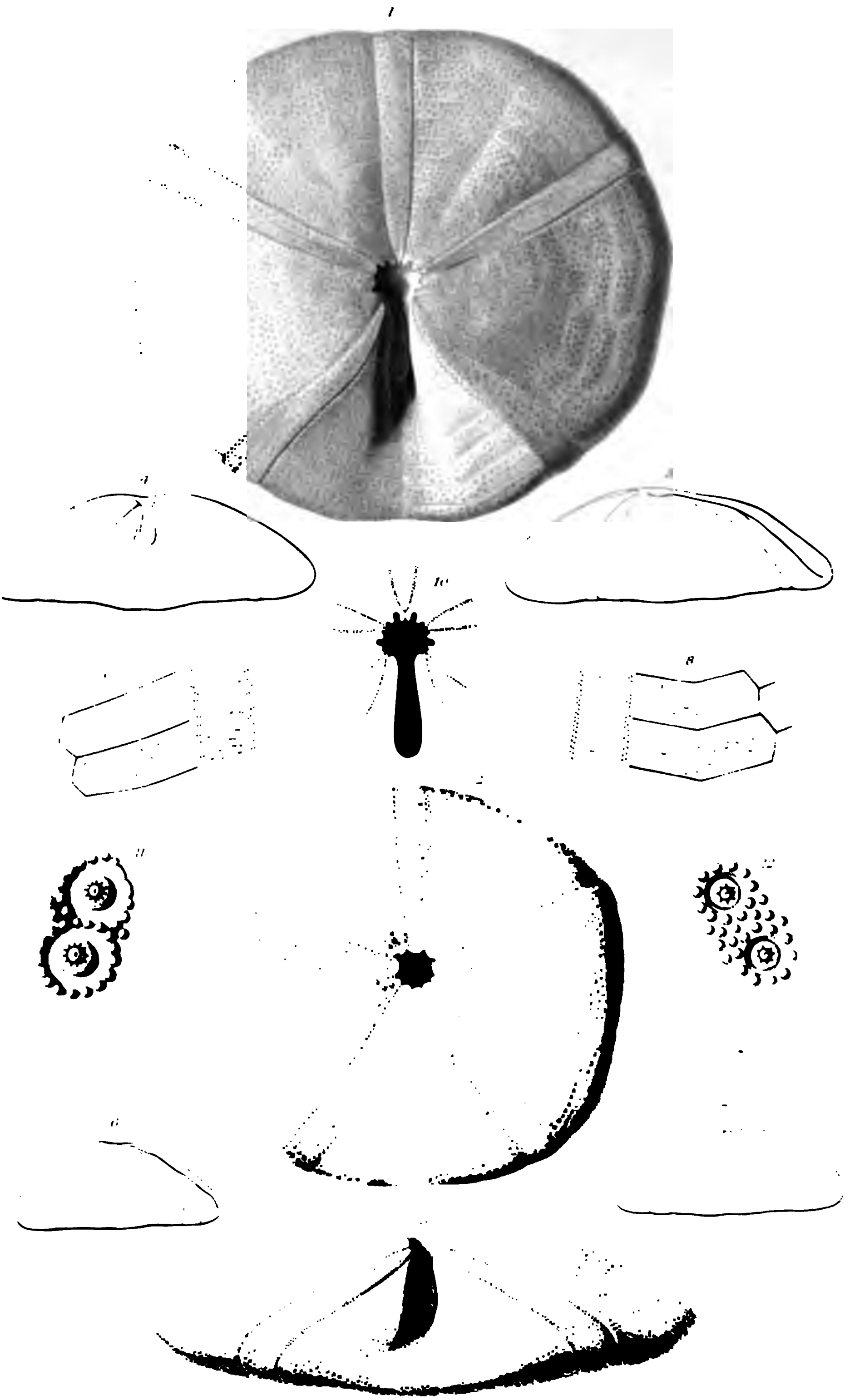


ACROSALENIA HEMICIDAROIDES *Wright*.



HYBOCLYPUS AGARICIFORMIS *Forbes*

A young specimen exhibits different proportions; it is one inch and $\frac{7}{12}$ths in length, by 1 inch and $\frac{8}{12}$ths in breadth. Its height is three fourths of an inch.

Locality and Geological Position. The specimens in the collections made by the Geological Survey are all from the Inferior Oolite. They are from the pea-grit of Crickley Hill in Gloucestershire, where they occur in company with the rarer *Hyboclypus caudatus;* from between Wayford and Seaborough in Dorsetshire, where they are accompanied by *Dysaster ringens* and *Galerites (Holectypus) hemisphericus;* and at Camlong Down near Uley Bury.

Hyboclypus gibberulus has been met with during the progress of the survey near Bridport, and in two other localities in Dorsetshire.

In figuring this species we are much indebted to Dr. Wright for his kindness in permitting us to make use of some fine examples in his possession.

EXPLANATION OF PLATE IV.

Fig. 1. A large specimen of *Hyboclypus agariciformis* seen from above.
Fig. 2. The under side of a smaller example.
Fig. 3. Terminal view.
Figs. 4. and 5. Outlines of a less expanded specimen.
Figs. 6. and 7. A young specimen, much more convex.
Fig. 8. Dorsal ambulacral and interambulacral plates.
Fig. 9. Ambulacral and interambulacral plates of under surface.
Fig. 10. Arrangements of the apex and anal groove.
Figs. 11. and 12. Tubercles and granules.

EDWARD FORBES.

October, 1852.

BRITISH FOSSILS.

DECADE IV. PLATE V.

HEMIPNEUSTES GREENOVII.

[HEMIPNEUSTES. AGASSIZ. (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Spatangidæ.) Body cordate, more or less tumid, in some species much elevated; ambulacra dissimilar, the lateral ones dorsally curved, petaloid or semi-petaloid, the odd one straight and lodged in a sulcus. Vent terminal supra-marginal. Mouth excentric, transverse. No fascioles. Genital pores four. Tubercles minute, perforated, placed on crenulated bosses.]

Hemipneustes Greenovii. Sp. Nov.

DIAGNOSIS. *H. testâ tumidâ ambitu cordato; ambulacro antico poris superne dissimilaribus alternatis; ambulacris antero-lateralibus serie externo pororum angustissimo, postero-lateralibus seriebus sub-similaribus.*

This curious and rare Echinite presents characters which distinguish it very strikingly from any described species. Its characters link together the genera HEMIPNEUSTES and TOXASTER, hitherto placed apart, even in different groups, the former being usually associated with *Ananchytes*, the latter with *Micraster*.

The well known *Hemipneustes radiatus* of the Maestricht Chalk is the type of its genus. In general contour it resembles an *Ananchytes*, but essentially differs in the structure of the test, for instead of the ambulacra being all similar and formed of homogeneous or nearly homogeneous parts throughout, the lateral ones are very unlike the anterior one, the former being partially petaloid, and the latter rectilinear. Its lateral ambulacra are, moreover, remarkable for being composed in their petaloid portions of differently constructed avenues, the hinder avenue of each being made up of pores widely separated and connected by a broad groove, whilst the fore one is made up of minute and closely approximated pairs of pores.

The genus *Toxaster*, on the other hand, was instituted for those heart-shaped urchins that resemble *Holaster* in general aspect, but have subpetaloid ambulacra in the manner of *Micraster*, differing, however, materially from the latter in the absence of any kind of fasciole. The depressed or slightly tumid shape of most of the known species is so very unlike that of *Hemipneustes radiatus*, that no comparison seems to have been instituted with it. Essentially, however, there appears to be no generic distinction between them, for though in several Toxasters the difference between the two series of avenue pores in the lateral ambulacra is very slight and indistinct, in others it is as great as in *Hemipneustes* proper. In *Toxaster complanatus* for example the two avenues of each lateral ambulacrum are similar ; so are they also nearly but not quite in *Toxaster gibbus* (Agassiz), *T. Ricordeanus* (Cotteau), and *T. Nicæensis* (Sismonda). But in *Toxaster oblongus* (Deluc) and *T. Verany* (Sismonda) they are nearly as dissimilar as they are in *Hemipneustes radiatus ;* and in the species now to be described the antero-lateral ambulacra have dissimilar avenues, and the posterolaterals nearly similar ones. Unless the *Toxaster oblongus, T. Moulini, T. semistriatus,* and *T. Verany* be regarded as species of *Hemipneustes,* and the name *Toxaster* be confined to those species resembling *T. complanatus* in the arrangement of the pores, (in which case my new species would become the type of a new and intermediate genus,) these two groups must be considered as forming but one natural genus. Such indeed is the view that I take of the assemblage, and the name *Hemipneustes,* as the older appellation, had best be retained for it.

The *Hemipneustes Greenovii* has a regularly cordate outline truncated posteriorly. It varies greatly in degree of tumidity, but appears always to present a high apex and hinder half, whilst the portion in front of the centre declines with a gentle curve, and is divided into two tumid cheeks by the rather deep and wide but not abruptly margined central furrow. The hinder extremity is perpendicularly truncate, and bears the vent at about half the height of the back. The under surface is flattened, but very slightly convex, and rounded at the side. The mouth, which is transversely oblong, is placed in a depression very near the anterior margin, opposite to the anteal furrow.

The ambulacra require to be separately described. The odd one is one third wider than the laterals. It preserves nearly an equal width throughout, and is composed of plates which become contracted vertically throughout its upper half. Out of about 37 plates seen in each of its two series, the lower seven are square or oblong, and large. They are each perforated near their outer and lower corners by a pair of minute approximated pores. In the narrow plates above these a very curious change takes place in the avenue arrangements for the pairs of pores; all become conspicuous, are alternately approximated, and set widely apart ; the latter pairs each consisting of a long outer pore and a short inner one. Inside of the pores there is a very small tubercle or two on each plate, the rest of the surface being covered by minute and closely set granulations ranged in transverse rows. The antero-lateral ambulacra are undepressed and superficial, and exhibit a slight and graceful curve; they are composed of an inner series of minute and approximated pairs of pores and of an outer or hinder series, in which the pores of each pair are widely separated and unequal (the outer ones being longest), and connected by a shallow groove. There are about 30 pairs of pores in the petaloid portion of each series; the petals gradually become narrow and cease about half way down the sides. In the postero-lateral ambulacra, the petals are also plane and undepressed, but are more regularly lanceolate in shape, in consequence of the two series of pairs of pores in each being of nearly similar structure and but slightly unequal in width. There are about 18 pairs in each petaloid avenue. A few tubercles are seen upon the lateral ambulacra. On the interambulacral spaces they are much more numerous, though set well apart and much larger. They are largest on the anterior segments, where they have wide areolæ. Their interstices over the whole of the test are occupied by minute granules, which are, however, not so small or so regularly arranged as those on the odd ambulacral plates. On the under surface the tubercles are confined for the most part to the interambulacral spaces, and are especially numerous, regular, and closely set on the ovato-lanceolate post-oral space formed by the inferior portion of the hinder interambulacrum. This space exhibits a prominent caudal gibbosity. The tubercles are minute and perforated; they are elevated upon crenulated bosses. The spines are unknown.

The apical disk is small, and is composed of four perforated genital plates, the perforations of which are approximated. In the midst of them is seen the madreporiform body. A fifth genital plate is imperforate. The five ocular plates are all perforated, but very minute.

The larger of the two specimens figured measures 1 $\frac{4}{12}$ inch in length, the same in breadth, and one inch in height. The smaller is 1 $\frac{1}{12}$ inch in length, the same in breadth, and $\frac{8}{12}$ths of an inch in height.

Locality and Geological Position. The Greensand of Blackdown in Devonshire, a formation whose geological horizon is probably about the junction of the Gault and Upper Greensand, if it be not a local condition of the Gault itself. The specimens described are in the Museum of Practical Geology.

EXPLANATION OF PLATE V.

Figs. 1. 2. 3. and 4. Represent various views of the more tumid variety.

Fig. 5. Is a profile of the depressed form.

Fig. 6. Ambulacral and interambulacral plates from the postero-lateral segment.

Fig. 7. Arrangement of the pores in the ambulacral avenues and structure of the apical disk.

Figs. 8. 9. and 10. Illustrations of the dispositions of the pores in the anteal ambulacrum.

Figs. 11. and 12. Primary tubercles and granules, magnified.

Note on another British species of HEMIPNEUSTES.

In lists of British fossils from the Lower Greensand a "*Spatangus complanatus*" is often mentioned, and referred to as the *Holaster* or *Toxaster complanatus* of the Neocomien of the Continent, a species upon which much stress has been laid by those geologists who have described foreign localities. In Mr. Morris's catalogue the *Holaster complanatus* is made synonymous with the *Spatangus retusus* of Lamarck and Goldfuss, and the *Spatangus argillaceus* of Phillips, which last-named fossil, judging from the figure given in the "Geology of Yorkshire," was an *Ananchytes* of the subgenus *Holaster*. The Upper Greensand of Wilts, the Gault of Speeton and Folkestone, and the Lower Greensand of Kent and Hants have been enumerated as formations in which the supposed "*Holaster complanatus*" is found. In Dr. Mantell's Medals of Creation (p. 355. lign. 84.) there is indeed a figure of "*Spatangus complanatus*, Chalk Marl, Hamsey," which, being evidently a representation of the true species of that name, might seem to imply not only that it is really British, but also that in England it is found in a very different geological position than on the Continent. But a comparison of the figures in question with those in Plate 2. of the "Echinodermes Suisses" shows that they are copies or tracings of the excellent representations of Neocomien, i.e. Lower Greensand examples, given by Agassiz in that valuable work. Probably *Holaster subglobosus* was the species intended by Dr. Mantell, and really found by him in the Chalk Marl of Hamsey. The specimens which have been mistaken for *Toxaster complanatus* in the Wiltshire Greensand were possibly my *Hemipneustes Greenovii;* those that I have seen so called from the Gault belong to more than one species of *Hemiaster*, and that from the Speeton clay was either a *Holaster* or a *Cardiaster* crushed. I have also seen examples of *Cardiaster Benstedi* marked *Spatangus complanatus* or *S. retusus.*

I can find no evidence whatsoever of the occurrence of the true *Toxaster* (i.e. *Hemipneustes*, as now redefined) *complanatus* in British strata. Very distinct sea-urchins, members of no fewer than four different genera, have been intended by that name in British lists.

One of these, a Lower Greensand species referred to by Dr. Fitton, is really a *Hemipneustes* of the section *Toxaster*. It differs however specifically from any known species, and I have named it HEMIPNEUSTES (TOXASTER) FITTONI.

It has the test tumid, ovate, depressed above, rounded inferiorly, with a shallow anteal sulcus. The lateral ambulacra are partially petaloid, and in that portion of their length lodged in very slight depressions. The avenues of pores in the odd ambulacrum are placed rather widely apart. Those of the antero-lateral ambulacra are slightly sinuous, and the outer ones are very slightly broader than the inner. There are about 36 pairs of pores in the petaloid part of each row. The postero-lateral ambulacra are much shorter and more symmetrical, and have about 16 pairs of pores in their petaloid parts of each row. The tubercles on the plates are small, pretty equal, and scattered profusely.

The dimensions of a moderately large specimen are one inch and $\frac{4}{12}$ths in length, one inch and $\frac{2}{12}$ths in breadth, and ten-twelfths of an inch in height.

In the Museum of Practical Geology is a specimen from Horseledge Point, near Shanklin, Isle of Wight, presented by Dr. Fitton, and another from Hythe, presented by Mr. H. B. Mackeson ; both from the Lower Greensand.

October, 1852. EDWARD FORBES.

HEMIPNEUSTES
(Cretaceous)

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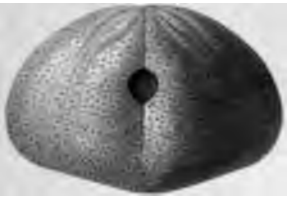

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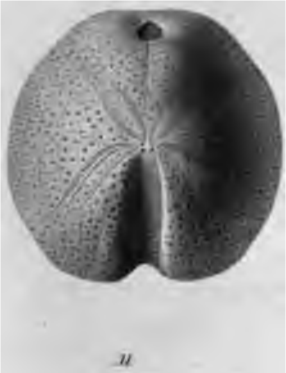

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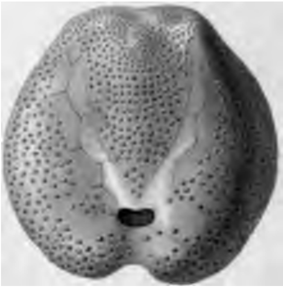

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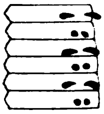

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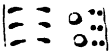

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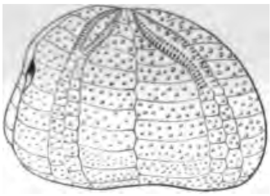

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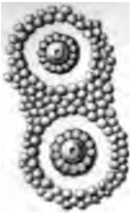

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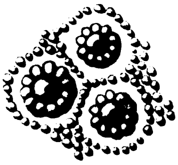

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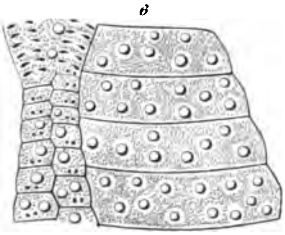

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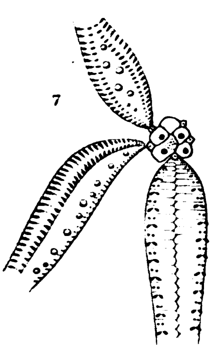

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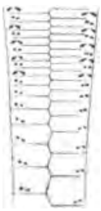

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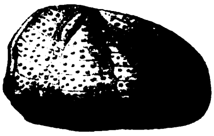


HEMIPNEUSTES GREENOVII *Forbes.*

BRITISH FOSSILS.

DECADE IV. PLATE VI.

ANANCHYTES OVATA.

[Genus ANANCHYTES. Lamarck. (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Ananchytidæ.) Body suborbicular; oblong or obscurely cordate, tumid; with homogeneous ambulacra, convergent on the vertex, all plane or with the anterior ambulacrum in a shallow furrow. No fascioles. Vent terminal, marginal or supra-marginal. Apical disk elongated and composed of four perforated genital and five perforated ocular plates. Tubercles perforate; their bosses crenulate. Spines minute. No dental apparatus.

Subgenus Ananchytes. Body ovate or orbicular; vent infra-marginal.]

Diagnosis. *A. ambitu ovato seu orbiculari, antice rotundato; testâ altâ tumidâ, ano infra-marginali.*

Forma α, *alta, hemispherica, ambitu ovato.*

Ananchytes ovata and conoidea, Auctorum.

Forma β, *(alta) elongata, superne depressa, ambitu ovato.*

Ananchytes striata, Auct. ? ovata pars.

Forma γ, *alta superne depressa, ambitu orbiculari.*

Ananchytes gibba, Agassiz.

Forma δ, *subglobularis.*

Forma ε, *alta, conica.*

Ananchytes conica, Agassiz. A. pyramidata, Portlock.

Synonyms. *Echinocorys vulgaris*, Breyn. Sched. de Echinis. p. 58. pl. 3., f. 1. 2. (1722.)

Echinocorytes ovatus, Leske ap. Klein. Nat. Disp. Echin. p. 178, pl. 53, f. 3., also *Echinocorytes pustulosus*, p. 180, pl. 16, f. A. B. *Echinocorytes scutatus*, p. 175, pl. 15. A. B., and pl. 42, f. 4. *Echinocorytes minor*, p. 183, pl. 16, C. D., and 17, a. b. (1778.)

Echinus ovatus, scutatus and pustulosus, Linnæus.

Ananchytes ovata, striata, gibba, pustulosa and semiglobus Lamarck. An. sans Vert. vol. iii., p. 25, 27.

Ananchytes ovata, conoidea, striata, gibba, pustulosa, hemisphærica, semiglobus and *corculum*. C. Desmoulins, Etudes sur les Ech., p. 368–376.

Ananchytes ovata, gibba, striata, Gravesii? semiglobus and conica. Agassiz. Cat. Syst., and Agassiz and Desor, Cat. Raisonné des Echinides, in Ann. des Sciences Nat. 3d series, Zoologie, vol. viii. p. 30.

Ananchytes ovata. Goldfuss, Petref. Germ., p. 145, pl. 44, f. 1. Bronn, Lethæa., t. 29, f. 23. Hisinger, Leth. Suec. p. 93, t. 26, f. 3. Geinitz, Grundriss der Verst., p. 332, t. 22, f. 19. Cuv. and Brongn. Geol. Paris, p. 15 and 390, pl. 5, f. 7. A. B. C. Mantell, Medals, p. 349. lign. 79. Portlock, Rep. Geol. Londonderry, &c., p. 354, pl. 17, f. 3. and 18, f. 2. Pictet, Traité Elem. vol. iv. pl. 5, f. 3. Agassiz, Echin. Suis. 1., p. 30, pl. 4, f. 9, 4, 6, (var. *conica*). Sismonda, Ech. Foss. Nizza., p. 13. Roemer, Nord. Deutsch. Kreide Geb., p. 35.

Ananchytes striata. Goldfuss, Pet. Germ., p. 145, plate 44, fig. 3, a. f. Grateloup, Ours. Foss., p. 60, pl. 2, f. 9.

Ananchytes conoidea. Goldfuss, Pet. Germ., p. 148, pl. 44, f. 2, a. b. c. Grateloup, Ours. Foss., pl. 2, f. 8.

Ananchytes hemisphærica. Cuv. and Brongn, Geol. Paris., p. 390, pl. 5, f. 8, A. B. C.

Ananchytes corculum. Goldfuss, Pet. Germ., p. 147, pl. 45, f. 2, a. b. c.

Echinites scutatus. Schlotheim, Petref. p. 319.

Echinocorys scutatus. Parkinson, Org. Rem. vol. iii. pl. 2, f. 4.

Echinocorys scutatus ovatus. Mantell, Geol. S. E. Eng. p. 373.

Ananchytes cretosus. Mantell, Wonders, p. 311, t. 52, f. 5.

Galea ovatus. Smith, Strat. Syst. p. 21. Upper Chalk Plate, fig. 10.

After many attempts to frame a concordance of the synonyms of this well known Echinite, I have been obliged to give up in despair, and even to displace their chronological order. In the above catalogue, which might be swelled to three times its dimensions by useless references to mere mentions of this species, I have placed in first rank the references to Breyn and Leske, since to them, and especially to the figures of the last-named author, all subsequent writers refer back. Next in order I have placed the references (in lump) to Lamarck, Desmoulins, and Agassiz, authors who have given catalogues of species, and whose lists in this case, according to my views, resolve themselves into a multiplicity of names for the varieties of one thing, names too which cannot be well reconciled with each other. Lastly, follow references to authors most of whom have given original figures of the species, in one variation or other, ranked in general in order of importance of quotation rather than priority of date. All the figures cited in these synonyms are preceded by a very good representation given by Dr. Plot in his Natural History of Oxfordshire (1677), delineating a flint cast of one of the ordinary forms of this Echinite.

It is to be regretted that the original appellation given to this fossil by Breyn, who styled it *Echinocorys vulgaris,* and figured it much better than Leske did, was not retained. Now, however, it is best for the convenience of science to preserve the Lamarckian name *Ananchytes ovata*, although originally given to one of the varieties only. Lamarck's names seem to be little better than so many designations for Leske's figures, not one of which, in this instance, deserves to be separated from the others as the type of a distinct species.

Goldfuss gave admirable representations of what seemed to him to be three or four distinct specific types, and applied to them in two instances the names used by Lamarck.

Agassiz and Desor admit eight species of *Ananchytes*, using the generic term in its most restricted sense. As all but two of these are types of which good figures are published, and as I consider all of them, except *sulcata*, to be probably varieties of one species, it is desirable that a few critical remarks should be made upon the list given by the distinguished naturalists just mentioned.

For *Ananchytes ovata* (Lamarck) they refer to Goldfuss's figure designated by the same name. This is my *Forma α*, and may be considered as the normal type of the species. The figure in Leske's work referred to by Lamarck as the representation of his *ovatus* is not exactly this, but one of the connecting links between my *Forma α* and *Forma ε*. The *Ananchytes corculum*, judging either from the old figures of Leske or the excellent ones of Goldfuss, is, it seems to me, the young of this form. I have received under the MS. name of *Ananchytes Bayfieldi* a similar young specimen. Portlock's first examples of *Ananchytes ovata* are of the normal type.

The second species in the "Catalogue Raisonné," *Ananchytes gibba* (Lamarck), is identified by Agassiz and Desor with the *A. rustica* of Defrance, and for a figure they refer to *A. striata var. subglobosa* of Goldfuss; that figure represents an example of my *Forma γ*; not, however, of the extreme type of that variation, but rather of a specimen inclining towards *Forma β*. The figure in Leske, referred to with a query by Lamarck, is still more near *β*, or rather is between *β* and *α*.

The third species in the "Catalogue Raisonné" is *Ananchytes striata* (Lamarck). In collections, full-bodied, long-topped, and comparatively smooth-sided *Ananchytes* are usually labelled with this name. *Ananchytes conoidea* and *striata var. marginata* of Goldfuss are referred to it; the former is a lofty example of my variation *β*, the latter a specimen intermediate between *β* and *α*. The *A. conoideus* of Portlock is truly this form; the *A. hemisphærica* of Brongniart is intermediate between it and the normal type. The *A. pustulosa* of Lamarck, founded on a figure by Leske, should surely rather be referred to a specimen intermediate between α and ε, and nearest α.

The fourth species, *Ananchytes Gravesii* of Desor, has never been figured or described at length, but from the brief note concerning it I think it may prove to be a form intermediate between β and δ.

The fifth, *A. tuberculata*, Defrance, is probably truly distinct.

The sixth, *A. semiglobus* (Lamarck), seems to be an intermediate form between α and ε, The figure in Leske is that of a young α.

The seventh, *A. conica*, Agassiz, has its extreme form in *pyramidata* of Portlock, and its variation passing into the normal type through the *Ananchytes ovata* figured in Part I. plate 4, figs. 4-6, of the *Echinodermes Suisses.*

The abundance of this *Ananchytes* in our Upper Chalk, and the fine state of preservation in which they are usually found, has enabled me to examine minutely and compare a great number of specimens; an inquiry the more desirable, as, according to some naturalists, and those of high repute, there are many species of the strict *Ananchytes* type, allies of *A. ovata*, whilst the experience of British collectors would rather incline in favour of the view that we have but a single species, exhibiting numerous variations. To this last view I feel compelled to assent, for however distinct the forms termed *ovata, gibba, striata, semi-globus, conica,* &c., may seem when selected and contrasted in the cabinet, every one of them is linked with the others by the most delicate shades of gradation. Neither in degree of elevation, rotundity, flatness of base, or curve of back, smoothness or roughness, can I find any constant character. Scarcely two individuals out of more than a hundred examples now before me exhibit the same proportions.

The specimens vary in outline of base from ovate or oblong to nearly round, and in outline of back from that of a depressed oblong hemisphere to an abruptly-sided pyramid. They vary also in degree of granulation of surface, in the number of primary tubercles, and in the height of the ambulacral and interambulacral plates. The number and proximity of pores in the avenues increase with age.

In a well-grown adult example, above 2½ inches in height, the dorso-lateral plates of the ambulacra are between 40 and 50 in number, and of the inter-ambulacra about half that amount. In a specimen 1 inch ½ in height the number of the ambulacral plates is under 30, and of the inter-ambulacrals half that amount. The differences in the number of the plates of the inferior surface are not so great.

The ambulacra are, dorso-laterally, at about the centre of the sides, in breadth to the interambulacra as 1–3. This proportion varies a little in different specimens, but without much regard to the general contour. Except in size, they exactly resemble the ambulacrals. On the upper third of the test they are small, short, and closely set; then gradually become taller down the sides and as they approach the margin. They and the interambulacrals are similarly ornamented with minute scattered primary tubercles, each of which is perforated and set upon a boss with a crenulated summit. On a large interambulacral plate in one of the rougher varieties I have counted as many as fifty tubercles, and yet they appear wide apart. The interspace is studded with scattered miliary granules forming imperfect rings around the tubercles. In an individual of one of the smoother varieties there may not be more than about fifteen tubercles upon the corresponding plate. The pairs of pores occupy each an ambulacral plate, and are placed near its centre, slightly oblique, a very shallow groove connecting the one pore with the other. In consequence of their closeness they are conspicuous near the apical disk, but are inconspicuous on the sides.

The base varies in degree of flatness, and specimens are occasionally found remarkably rounded at the margins; usually, however, it presents an extensive flattened surface. At one extremity of it is seen the longitudinally elliptical vent, near the other the transversely oval mouth. The space between the mouth and vent is plane, and occupied by the subanal plates of the posterior interambulacral segment. There are about six of these plates in each alternate row, and their inner margins are curved hindwards. They are covered with tubercles, thickly set, and consequently contrasting with the bordering inferior ambulacral plates, which are minutely granulated but not tuberculated, and present the aspect of a lanceolate rough space or elongated escutcheon, the base of which is formed by a raised ovate leaflike space in front of the vent, marking the position of internal buttresses. The tubercles on the anterior portion of this space are smaller than those of its hinder half and than those of the escutcheon that embraces it. They are also more scattered, and are more separated by minute granules. The postero-lateral ambulacrals in their basal portion are elongated to reach the mouth, and their plates become longer and somewhat polygonal, so that the pores are more distant than they are on the sides and margin. The other ambulacra, in consequence of the exceedingly excentric position of the mouth, near which they widen out, are much shortened and close set below, and the pores of all five in the immediate neighbourhood of the mouth form a sort of irregular star, the longest rays of which are formed by the buccal extremities of the antero-lateral ambulacra. The mouth is lodged in an oblique depression; its lips are thickened; the hinder one is highest, but does not overlap. The vent is set obliquely and submarginally.

The apical disk is much elongated. It is composed of four large and perforated genital plates (the fifth is usually obsolete) and five large oculars; of the two anterior genital plates, the right one is the largest, in consequence of its including the madreporiform body in its constitution. This organ is not conspicuous, but under the lens its punctations, which are exceedingly minute, may be detected. Of the two hinder genital plates, the left one is largest. They are all polygonal. Of the ocular plates, the two antero-laterals are much larger than the other three plates. The eye perforations are marginal; the genital holes sub-central. All the plates are thickly covered with granules and bear a few tubercles. On flint casts the position of the central portion of the apical desk is marked by a space included within an oblong groove. This groove is caused by the impressions of the walls of a solid oblique tube-like body projecting from the inner surface of the apical disk into the cavity of the test, and directed backwards. This organ appears to me to be the sand canal, and is connected with the madreporiform plate. On flint casts the pores of the avenues are seen strongly projecting, and on each side of the vent is a shallow groove marking the place of internal strengthening buttresses.

The following table exhibits the comparative measurements in inches and the configuration of the dorsal contour, in seventeen examples, all differing strikingly from each other.

Specimen.	Height.	Length.	Breadth.	Form of hinder dorsal inter-ambulacral area.	Contour of the dorsal surface.
1	$2\frac{4}{12}$	$3\frac{2}{12}$	$2\frac{10}{12}$	Rounded -	Very wide and flattened.
2	$2\frac{7}{12}$	$3\frac{2}{12}$	$2\frac{7}{12}$	Carinated -	Wide and flat.

Specimen.	Height.	Length.	Breadth.	Form of hinder dorsal inter ambulacral area.	Contour of the dorsal surface.
3	$2\frac{6}{12}$	$3\frac{6}{12}$	3	Carinated -	Wide and rather flat.
4	$2\frac{5}{12}$	$3\frac{6}{12}$	$2\frac{9}{12}$	Carinated -	Wide and very flat.
5	$2\frac{6}{12}$	$3\frac{2}{12}$	$2\frac{4}{12}$	Much carinated and elevated.	Gently declining from apex.
6	$2\frac{5}{12}$	$2\frac{4}{12}$	$2\frac{2}{12}$	Rounded -	Gently curving.
7	$2\frac{3}{12}$	$2\frac{8}{12}$	$2\frac{3}{12}$	Carinated -	Gently curving.
8	$1\frac{11}{12}$	$2\frac{11}{12}$	$2\frac{5}{12}$	Carinated -	Flattened slightly.
9	$1\frac{7}{12}$	$2\frac{5}{12}$	$1\frac{10}{12}$	Carinated -	Flattened.
10	$1\frac{11}{12}$	$2\frac{6}{12}$	$2\frac{1}{12}$	Carinated -	Gently curving, and slightly flattened.
11	$2\frac{1}{12}$	$2\frac{4}{12}$	$2\frac{1}{12}$	Carinated -	Curving.
12	$2\frac{3}{12}$	$2\frac{8}{12}$	$2\frac{3}{12}$	Carinated -	Flattened.
13	$2\frac{3}{12}$	$3\frac{1}{12}$	$2\frac{7}{12}$	Carinated -	Rapidly curving, and flattened behind.
14	$2\frac{2}{12}$	$2\frac{11}{12}$	$2\frac{5}{12}$	Sub-carinated	(Tumid below, and) Conic above.
15	$2\frac{5}{12}$	$2\frac{10}{12}$	$2\frac{3}{12}$	Carinated -	(Tumid below, and) Conic above.
16	$1\frac{8}{12}$	$1\frac{9}{12}$	$1\frac{6}{12}$	Carinated -	Conical, with slightly curved sides.
17	$2\frac{2}{12}$	$2\frac{6}{12}$	$1\frac{9}{12}$	Sub-carinated	Pyramidal, with straight sides.

The last specimen in this table is the original example of *Ananchytes pyramidata* of Portlock, and the most extreme of all the varieties.

Locality and Geological Position. *A. ovata* is a characteristic fossil of the White Chalk, and is found abundantly in the south-east of England, especially in Kent, Surrey, Sussex, and the Isle of Wight. It occurs in both middle and lower parts of the series. *Forma* δ *subglobularis* and β *striata* are prevalent in the Lower Chalk. In

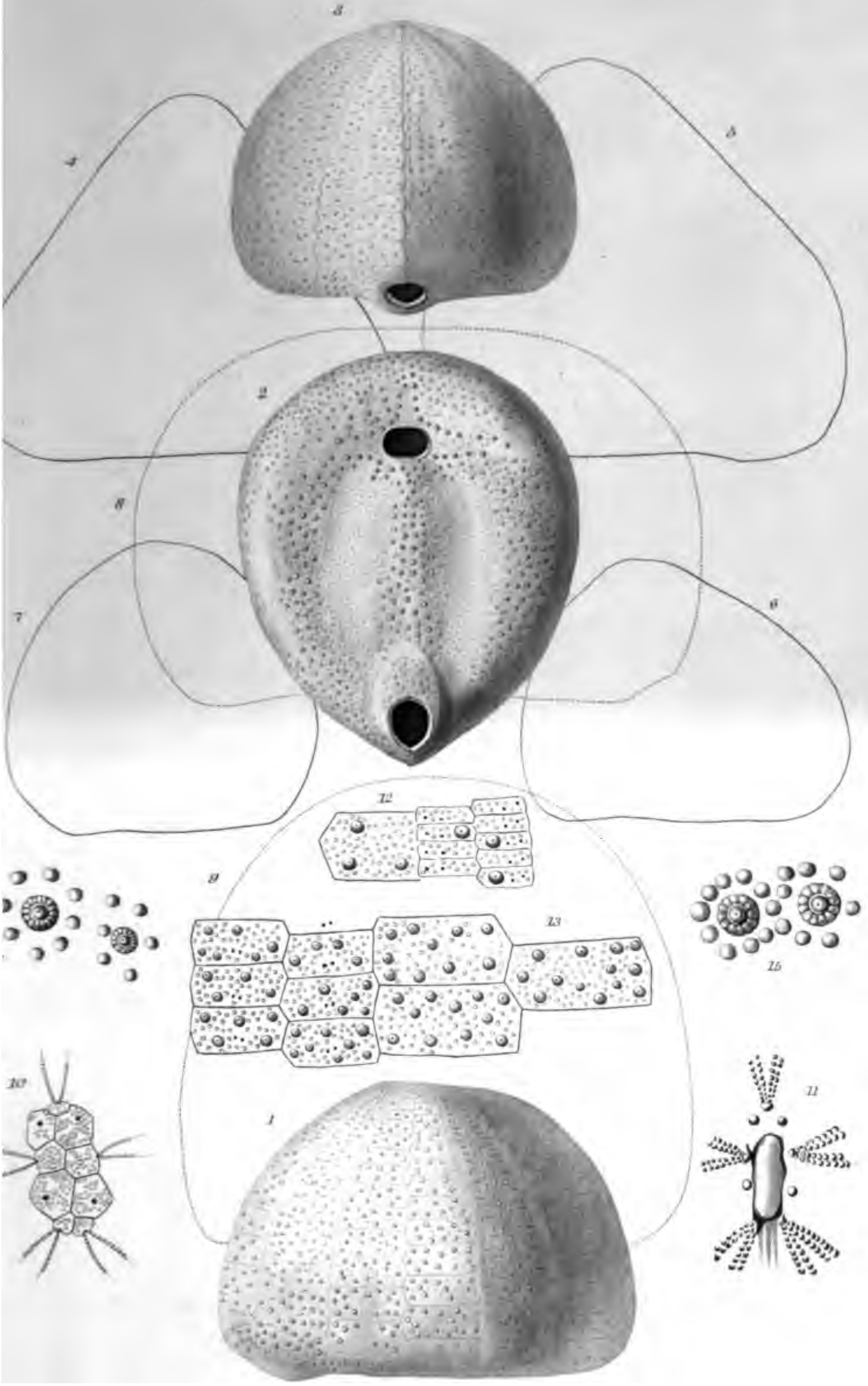
Ireland Colonel Portlock observed *Forma α ovata* to be characteristic of the lower beds there. In England that variety is chiefly from the upper beds. All the varieties occur as flint casts among gravel.

Specimens with slightly tumid plates from County Derry in Ireland were referred by Portlock to the *Ananchytes sulcatus* of Goldfuss, a Maestricht species. They are, however, unquestionably only peculiar examples of *A. ovatus*. The supposed British *Hemipneustes radiatus* recorded by Dr. Mantell is only *Ananchytes ovatus*, as the original examples in the British Museum show.

EXPLANATION OF PLATE IV.

Figs. 1. 2. and 3. Different views of an example of the common Forma α.
Fig. 4. Forma ε *pyramidatus* from the original specimen.
Fig. 5. A very unsymmetrical example of Forma ι.
Fig. 6. A similar example more tumid in outline.
Fig. 7. A subglobular specimen, Forma δ.
Fig. 8. A much elongated example of Forma β.
Fig. 9. A very elevated example of Forma γ.
Fig. 10. The plates of the apical disk.
Fig. 11. The interior impressions of the apical disk as seen upon a flint cast, showing the furrow indicating the position of the base of the sand canal.
Fig. 12. Ambulacral and interambulacral plates from near the apex.
Fig. 13. Similar plates from the sides.
Fig. 14. Tubercles and granules of the upper surface.
Fig. 15. Tubercles and granules of the lower surface.

October, 1852. EDWARD FORBES.



ANANCHYTES OVATA. Lamk.

BRITISH FOSSILS.

DECADE IV. PLATE VII.

ANANCHYTES (HOLASTER) SUBGLOBOSA.

[Genus ANANCHYTES. LAMARCK. (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Ananchytidæ.) Body orbicular, oblong, or obscurely cordate, tumid; with homogeneous ambulacra, convergent on the vertex, all plane, or with the anterior ambulacrum in a shallow furrow. No fascioles. Vent terminal, marginal or supra-marginal. Apical disk elongated, and composed of four perforated genital and five perforated ocular plates. Tubercles perforate, their bosses crenulate. Spines minute. No dental apparatus.

Sub-genus HOLASTER. Body cordate. Vent terminal and supra-marginal.]

DIAGNOSIS. *A. ambitu subcordato; testâ crassâ, tumidâ, lateribus rotundatis.*

FORMA *a. Normalis, tumida, cordata.*

FORMA *β. Expansa, depressa.*

ANANCHYTES SPATANGIFORMIS, ROEMER, Norddeutsch. Kreide Geb., p. 35, pl. 6, fig. 19.

FORMA *γ. Globosa, suborbicularis.*

FORMA *δ. Cordata, tumida, anticé sulcata.*

SYNONYMS.—*Spatangus subglobosus,* LESKE ap. KLEIN, Nat. Disp. Echin., p. 240, pl. 54, f. 2, 3. (1778.) DEFRANCE, Dict. Sc. Nat., vol. i., p. 94. GOLDFUSS, Petrefacta Germanica, p. 148, pl. 45, f. 4. DESMOULINS, Tabl. Synopt., p. 398.

Echinus subglobosus, GMELIN.

Holaster subglobosus, AGASSIZ, Prod. in Mem. Soc. d'Hist. Nat. de Neuchâtel, p. 183. Echin. Suisses, pt. i, p. 13, pl. 2, fig. 7, 9. ROEMER, Norddeutsch. Kreide Geb., p. 34. REUSS, Boehm. Kr., p. 57. SISMONDA, Ech. Foss. Nissa., p. 5. AGASSIZ and DESOR, Cat. Raisonné des Echinides, Ann. des Sc. Nat., 3d ser., vol. viii. p. 27. DIXON, Geol. Sussex, p. 341, pl. 2, f. 2. and 1 and 2.

The figures given by Leske of this well-known Echinite were sufficiently characteristic to prevent the commission of many subsequent errors. Lamarck, however, applied the name to a tertiary fossil. Since his time palæontologists have been content to preserve Leske's name for this species.

The body varies in outline from broadly sub-cordate to sub-orbicular, and from depressed to spheroidal. The ambulacra are regularly radiate and linear lanceolate, the apices of the three anterior ones converging at some small distance from those of the two posterior ones, which meet at their tips very closely. The breadth between the avenues of pores is nearly equal in all, but the breadth of the double series of ambulacral plates is greater in the lateral ones than in the odd or anterior ambulacrum. Of the interambulacra, the hinder or odd one and the antero-laterals are narrower than the postero-laterals. In the uppermost portion of each ambulacrum the plates are broad and very short, and five of them go to the breadth of an interambulacral plate; but about half way down the sides they widen out, and near the turn of the base not more than two equal an interambulacral plate. In the dorsal portion of each lateral avenue the pores of each pair are set well apart and connected by a furrow, but below the middle and in the wider plates they become smaller and closer. There are about 30 or so of the wider pairs. In the odd ambulacrum they are nearly similar throughout. The total number of pairs of pores is between 35 and 50, the number in the odd ambulacrum being less than in the others. The surfaces of the dorsal and lateral plates of all the segments bear very minute equal primary tubercles scattered and intermingled with minute miliary granules on the under surface especially; on the ambulacral segments in the neighbourhood of the mouth the tubercles become larger. On the anterior portion of the broadly lanceolate ventral posterior interambulacral segment they are closely set and somewhat regularly arranged, but become more scattered on its hinder part. On the ventral ambulacral segments there are very few tubercles but closely set granules. All the tubercles are perforated and set upon bosses with crenulated summits. The sides are tumid and rounded in all the varieties; the cheeks rather swollen. There is a shallow depression in front of the mouth terminating the more or less marked anteal sulcus. The mouth itself is transversely oblong; its upper lip is higher than the lower, and thickened. The buccal extremities of the avenues form an irregular and obscure star around it. The anal extremity of the test is obtusely truncate, and in the more cordate examples slightly hollowed out vertically beneath the vent. That orifice is placed at about or a little lower than half the height of the test. It is vertically elliptical. The apical disk is much elongated; it is composed of four perforated genital plates, of which that combined with the rather conspicuous madreporiform body is largest, and of five perforated oculars, of which the two antero-laterals are much larger than the others; it is the size and contiguity of these plates that chiefly cause the elongation of the disk. The fifth or posterior genital plate is minute and imperforate. On the cast there are traces of the presence of an internal sand-canal. The test is remarkably thick in substance, especially beneath.

The following table of the comparative dimensions of six specimens selected on account of their differences will serve to illustrate the variation of proportions in this species.

No.	Locality.	Stratum.	Length.	Breadth.	Height.
1	Dover - -	Chalk Marl -	$2\frac{4}{12}$	$2\frac{5}{12}$	$1\frac{10}{12}$
2	" - -	Lower Chalk -	2	2	$1\frac{3}{12}$
3	Chaldon -	Chloritic Marl -	$1\frac{11}{12}$	$1\frac{11}{12}$	$1\frac{4}{12}$
4	" - -	" "	$1\frac{11}{12}$	2	$1\frac{2}{12}$
5	" - -	" "	$1\frac{6}{12}$	$1\frac{5}{12}$	$1\frac{1}{12}$
6	" - -	" "	$1\frac{7}{12}$	$1\frac{6}{12}$	$1\frac{2}{12}$

Varieties. There is a curious variety of this species, apparently an abnormality, in which the anterior sulcus is impressed into a deep and almost acute furrow. I have found it at the junction of the Chalk Marl and Upper Greensand near Abinger in Surrey, and there is a very fine and large specimen of it in the British Museum.

Occasionally casts in Greensand are found extremely compressed. One of these appears to be the *Spatangus Murchisoni* of König, Icones Sectiles, f. 169. The figure of *Spatangus hemisphericus* of Phillips' Geology of Yorkshire, pt. i, pl. 1, fig. 15, bears a close resemblance to this species also, partially compressed. The "*Spatangus argillaceus*" from the Speeton Clay, of the same work, is evidently a *Holaster*, and possibly this species. In cabinets specimens of a *Hemiaster* from the Gault are often so labelled by mistake.

Locality and Geological Position. This urchin abounds in the bed of Chalk with green grains intervening between the Upper Greensand and Chalk Marl. It is found also plentifully in the

Chalk Marl itself, and more rarely in the Lower Chalk. It occurs in all the English counties where these beds are found. It has not been observed in Ireland.

EXPLANATION OF PLATE VII.

Figs. 1. 2. 3. and 4. Views of an example of the normal form. The specimen selected is from the chloritic marl of Dorsetshire.

Figs. 5. 6. 7. and 8. Outlines of different varieties from the chalk marl.

Fig. 9. The apical disk.

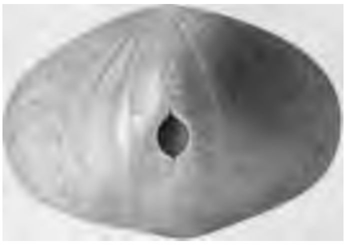
Fig. 10. Ambulacral and interambulacral plates from the upper portions of their segments.

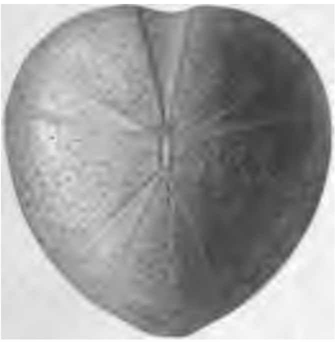
Fig. 11. A tubercle and granules from the upper surface.

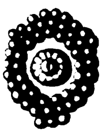
Fig. 12. A tubercle and granules from the lower surface.

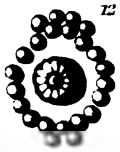
EDWARD FORBES.

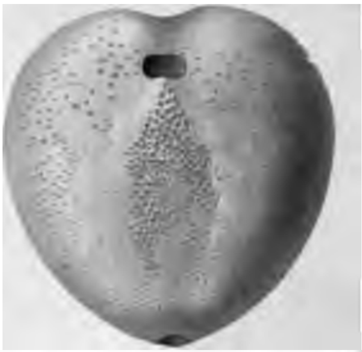
October, 1852.

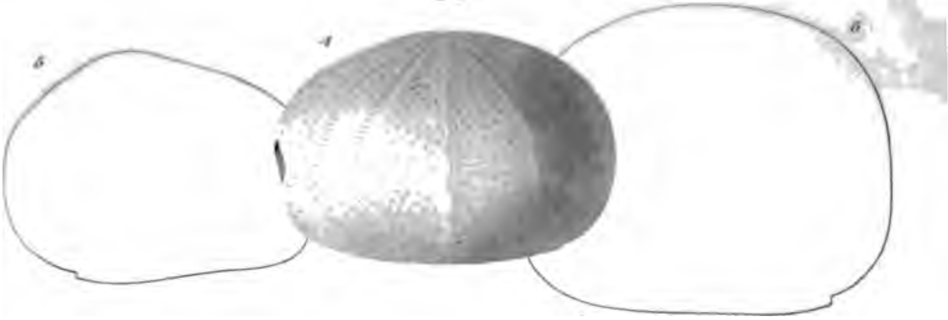


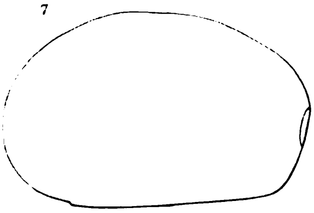


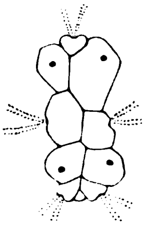


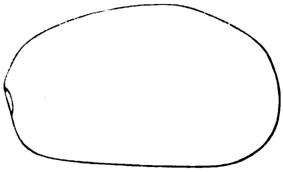


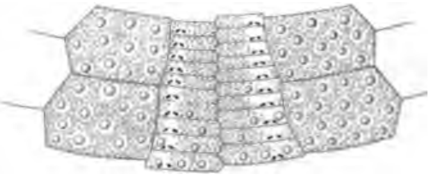












ANANCHYTES (HOLASTER) SUBGLOBOSUS. *Leske*

BRITISH FOSSILS.

DECADE IV. PLATE VIII.

ANANCHYTES (HOLASTER) PILULA.

[Genus ANANCHYTES. LAMARCK. (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Ananchytidæ.) Body orbicular, oblong or obscurely cordate, tumid, with homogeneous ambulacra convergent on the vertex, all plane or with the anterior ambulacrum only lodged in a shallow furrow. No fascioles. Vent terminal, marginal or supra-marginal. Apical disk elongated, and composed of four perforated genital and five perforated ocular plates. Tubercles perforate, their bosses crenulate. Spines minute. No dental apparatus.

Subgenus HOLASTER. Body subcordate, vent terminal, supra-marginal.]

DIAGNOSIS. ***A. ambitu vix cordato; testâ altâ hæmisphæricâ tumidâ inferne planatâ; ano alto.***

SYNONYMS. ***Ananchytes pilula***, LAMARCK. An. sans Vert., vol. iii. p. 27.

Spatangus prunella ? MANTELL, Geol. Sussex, p. 193, pl. 17, f. 22, 23.

Spatangus pilula, DESMOULINS, Tabl. Syn. des Echin., p. 406.

Ananchytes analis, ROEMER, Norddeutsch. Kr. p. 35, pl. 6, f. 18.

Holaster pilula, AGASSIZ, Cat. Syst. p. 1. AGASSIZ and DESOR, Cat. Raisonné des Echin., in Annales des Sc. Nat. 3d ser., vol. viii. p. 29. FORBES, in Dixon's Geol. Sussex, p 341, pl. 24. f. 10, 12 (junior).

Holaster coravium ? FORBES (not of Lamarck), in Dixon's Geol. Sussex, p. 342, pl. 24, f. 7–9.

Body oblong, lofty, always elevated, but not always to the same degree, tumid above, flattened below, and with sharply angulated sides, anteally obtuse and flattened, posteriorly abruptly truncate, vertex slightly in front of apical disk; posteal interambulacral area highly arched in the dorsal region and slightly carinated, projecting over the oblong or round vent, which is placed at a considerable elevation, usually about half-way up the total height. Dorsal portions of the ambulacra quite plane; in some examples the lower part of the anteal or odd ambulacrum is slightly excavated. Plates of the ambulacra large and broad, each equalling as much or rather more than half the height of an interambulacral plate. In a rather large example of this species there are 17 dorsal plates in each vertical row of the odd ambulacrum, about 14 and 13 respectively in the rows of each lateral ambulacrum, and 7 in each vertical row of each lateral interambulacrum. These plates all bear minute scattered primary tubercles, with interspersed granules. The margins of the plates are in some examples slightly prominent, and as if marked by a bordering line; more usually they are quite plane, and occasionally slightly impressed. Beneath, the mouth is placed very near the anteal extremity, at about or less than one fourth of the length of the test from the margin, which in the region of the odd ambulacrum is slightly sinuous. The two posterior ambulacra are necessarily much longer than the others below, and proceed from near the hinder extremity to the mouth, their course marked by a slight depression. Their plates become elongated and polygonal, and though thickly strewn with granules bear very few primary tubercles. These last are more developed on the escutcheon-like area formed by the ventral portion of the odd or posterior interambulacrum. The mouth itself is roundish or ovate, its fore lip is depressed, its hinder lip tumid and elevated but not overlapping. The apical disk is with difficulty distinguished from the neighbouring plates; it is much elongated, its genital and ocular pores are minute, and the madreporiform body not very strongly marked. On flint casts the four genital pores are usually strongly impressed, as also are the pores of the avenues, which form homogeneous rows indistinctly indicated, owing to their distance from each other, and their minuteness.

The varying proportions of this species may best be illustrated by the following comparative measurements (in inches and parts of inches), of six specimens of slightly different bulk.

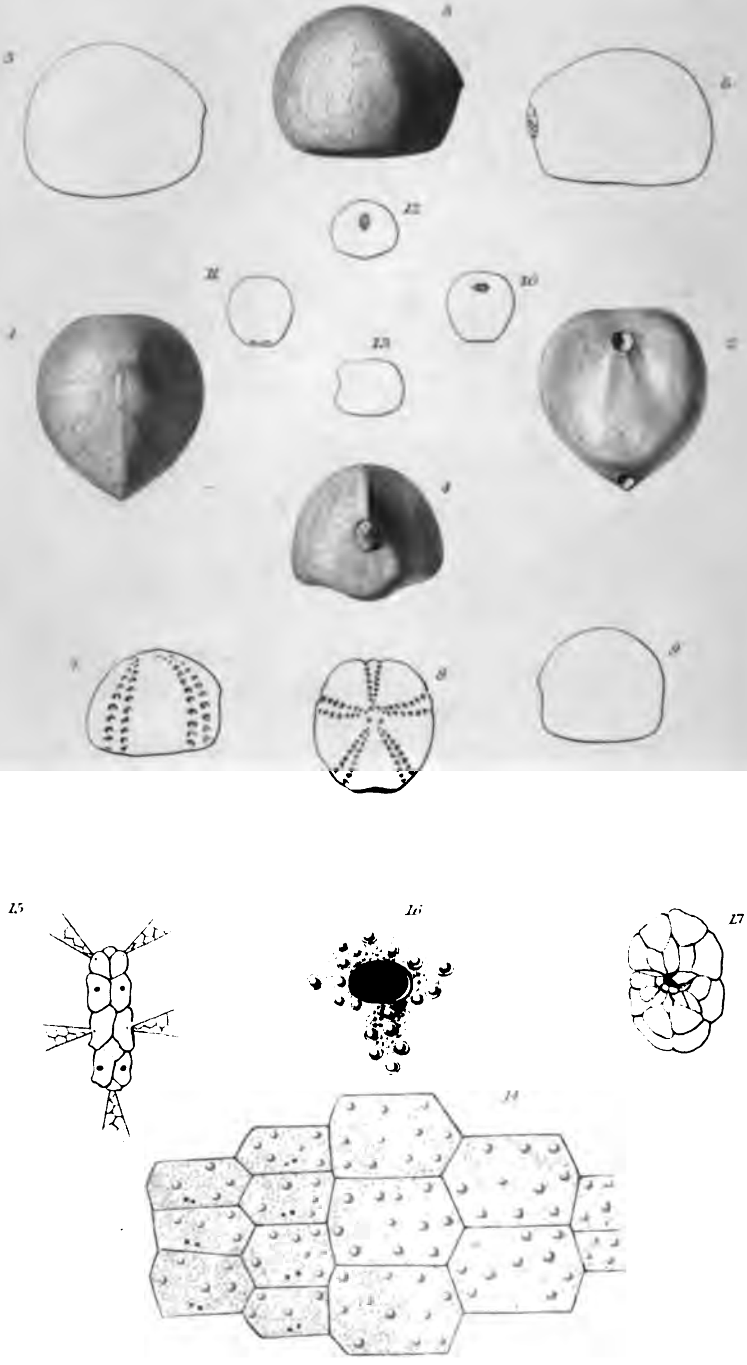
—	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Height -	$0\frac{8}{10}$	$0\frac{5}{8}$	$0\frac{1}{2}$	$0\frac{1}{2}$	$0\frac{4}{10}$	$0\frac{11}{12}$
Length -	1	$0\frac{8}{10}$	$0\frac{7}{10}$	$0\frac{8}{10}$	$0\frac{6}{10}$	$0\frac{11}{12}$
Breadth -	$0\frac{8}{10}$	$0\frac{7}{10}$	$0\frac{7}{10}$	$0\frac{6}{10}$	$0\frac{6\frac{1}{2}}{10}$	$0\frac{9}{12}$
Height of vent above margin }	$0\frac{3}{10}$	$0\frac{3}{10}$	$0\frac{2}{12}$	$0\frac{2}{12}$	$0\frac{2}{12}$	$0\frac{2}{10}$

I believe there is little doubt of this pretty urchin being the *Ananchytes pilula* of Lamarck, whose brief diagnosis "*A. minima,* "*ovato-globosa, subtus convexiuscula, ano in summo margine,*"

DECADE 4 PL. 8.

ological Survey of the United Kingdom.

ANANCHYTE
(Cretaceous)



ANANCHYTES (HOLASTER) PILLULA *Lamarck.*

is a very insufficient description. Dr. Mantell, who was the first to notice it in England, referred it with a doubt to the *Spatangus prunella*, at the suggestion of the late Mr. König. With the latter fossil, however, which is a very curious species of *Hemiaster* well known at Maestricht, it has no near affinity. Roemer has given a good figure of the true type under the name of *Ananchytes analis*. Its aspect and the arrangement of its ambulacral plates are strikingly those of an *Ananchytes*, whilst the position of its vent is that of an *Holaster*. I regard it as a link between the groups, both being sections only of one natural genus. In some examples of this fossil the minute granules towards the side margins show a tendency to collect into a fasciole, a feature indicative of an affinity with *Cardiaster*.

Locality and Geological Position. In the Upper Chalk of Kent, Sussex, and other English counties.

Explanation of Plate VIII.

Figs. 1. to 6. Various views of adult examples.
Figs. 7. and 8. Flint casts.
Fig. 9. A half grown example.
Figs. 10. to 13, young specimens.
Fig. 14. Ambulacral and interambulacral plates from the sides.
Fig. 15. The apical disk.
Fig. 16. The mouth.
Fig. 17 The vent, with its ossicles.

Edward Forbes.

October, 1852.

BRITISH FOSSILS.

DECADE IV. PLATE IX.

CARDIASTER GRANULOSUS.

[Genus CARDIASTER. FORBES (1850). (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Ananchytidæ.) Body cordate, tumid or depressed; lateral ambulacra having the upper part of their avenues slightly dissimilar; all the ambulacra convergent on the vertex, the anterior one lodged in a strongly marked sulcus with angulated sides. A fasciole passing beneath the anus and continued on the sides. Apical disk elongated, and composed of four perforated genital and five perforated ocular plates. Tubercles perforate, their bosses crenulate. No dental apparatus.]

DIAGNOSIS. *A. ambitu regulariter cordato, dorso depresso, tuberculis primariis anticis conspicuis.*

SYNONYMS. *Spatangus granulosus*, GOLDFUSS, Pet. Germ. p. 148, pl. 45, fig. 3. (1826-33.) DESMOULINS, Tabl. Syn. p. 410.

Spatangus cordiformis, WOODWARD, Geol. Norf. p. 50, pl. 5, fig. 6. (1833.)

Holaster granulosus, AGASSIZ, Prodr. Ech. p. 16. AGASSIZ and DESOR, Cat. Rais. des Echin. in Ann. des Sc. Nat. 3d ser. vol. viii. p. 27.

Holaster equalis, PORTLOCK, Geol. Rep. Londonderry, &c. p. 355. pl. 17, a. b. c.

Cardiaster cordiformis, FORBES, Ann. Nat. Hist. 2d series, vol. vi. p. 443.

On a recent visit to Ciply I had an opportunity of collecting the *Spatangus granulosus* of Goldfuss *in situ*, and recognized in it the same Echinite which has been noticed and figured by Mr. Samuel Woodward, in his "Outline of the Geology of Norfolk," under the name of *Spatangus cordiformis*. The flint casts from the chalk of the north of Ireland, described by Colonel Portlock under the name of *Holaster equalis*, and now in the collections of the Geological Survey, evidently belong to the same species.

I constituted this genus for the species now represented and described, and also for the curious *Spatangus excentricus* figured in Woodward's work, above cited. Finding that there is a distinct fasciole present in these urchins, and that this character is accompanied by peculiarities in the ambulacra, and, as far as I know, invariably by the presence of a deep anteal sulcus with carinated sides, I felt warranted in separating them generically from the *Holasters* with which they had previously been associated.

The *Spatangus ananchytis* of Leske, quoted by Lamarck with doubt for his *Ananchytes cordata*, is evidently a *Cardiaster* in a peculiar mineralized condition similar to that exhibited by examples from cretaceous beds near Biarritz, which, judging from a specimen communicated by Mr. Pratt, seem to be very closely allied to if not identical with *Cardiaster granulosus.*

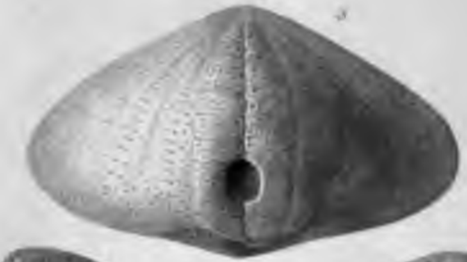
The outline of this elegant fossil is regularly cordate. In front it is deeply furrowed by the sulcus for the odd ambulacrum, which excavation has angulated but sloping margins. Behind it is obtusely truncate. The general form is expanded, usually as broad as long. The back is depressed, the apical disk nearly central, the hinder interambulacral segment gently arched and declining, the vent placed low, the margins of the body rounded yet somewhat compressed, the base flattened yet slightly convex, the mouth close to the anteal margin and at the extremity of the deep groove, that terminates the odd ambulacral furrow. The test varies in degree of convexity and expansion, but on the whole is very constant in form. All the dorsal plates are thickly covered with minute granules interspersed with tubercles, the latter consisting of a perforated knob placed on a crenulated boss, and surrounded by a smooth areola. These tubercles are very unequal. On the anterior interambulacral spaces, but confined to their inner halves, are two rows of tubercles much larger than any of the others. A similar series of large tubercles runs along the carinated portion of the posterior interambulacral area, above the vent. On the under surface the tubercles are thickly grouped and moderately large, especially near the sides, and on the lanceolate post-oral spinous space; but there are only granules on the two broad avenues formed by the inferior continuations of the posteal ambulacra, or on the central portion of the anteal ambulacrum.

In the dorsal portion of the odd ambulacrum the avenues of pores are homogeneous throughout, the pores of each pair are placed close together, and the pairs become more distant as the plates become larger. There are about 28 plates visible in a well grown example. The antero-lateral ambulacra are sub-petaloid in their upper part, and unsymmetrical in consequence of the pores of each pair being wider apart in the outer row than in the inner, and moreover being united by a deeper groove. There are about 24 pairs of pores in the broader or subpetaloid portion of each series, they are closely approximated, and those that are below widen out; the outer series is slightly arcuated. In the postero-lateral ambulacra the two series are nearly similar, and there are about 18 pairs of pores in the upper or subpetaloid portion of each series. There are about 9 plates in each series in the dorsal portion of the

ogical Survey of the United Kingdom.

CARDIASTER
(Cretaceous)

3



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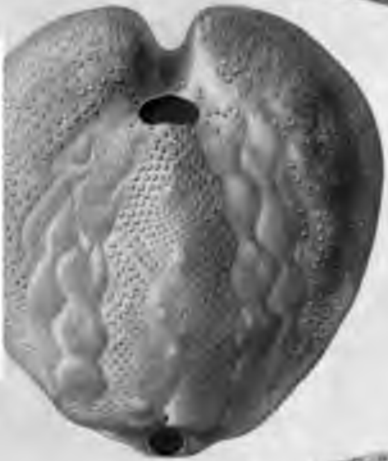

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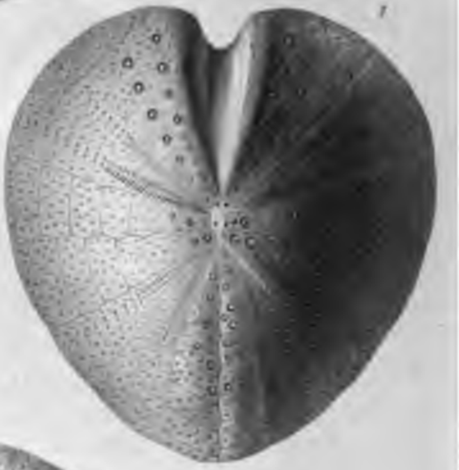

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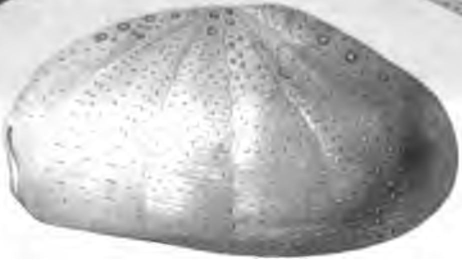

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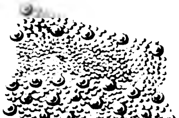

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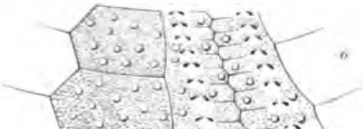

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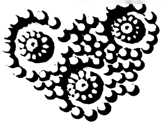

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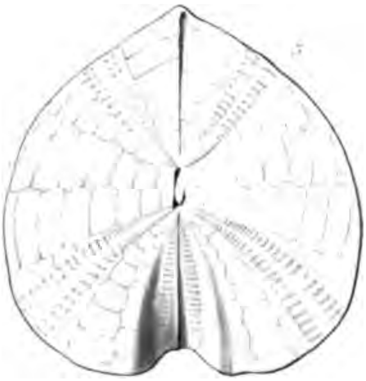


10

lateral interambulacral segments, and 10 above the vent in the posterior segment. The infra-anal portion of the latter is composed of two series of five irregularly polygonal plates each; they are remarkable for presenting gibbosities at regular intervals. In the inferior portions of each postero-lateral ambulacrum there are 7 plates in each series. These are polygonal, large, and elongated, and bear the pairs of pores, which are minute and oblique, close to their inner angles. The pores of the ambulacra around the mouth form an obscure star.

The fasciole passes beneath the anus with a curve, and runs along the sides just above the margin, but becomes obscure or lost upon the anterior interambulacral segments. It is narrow, and free from intermingled tubercles. On bad specimens it can hardly be traced, but upon good ones is very evident.

The apical disk is covered with granules similar to those of the neighbouring plates, so that its elements are but obscurely defined; it is composed of four perforated genital and five perforated ocular plates. An imperforate genital plate is also present, but insignificant. The madreporiform body is very indistinctly marked. The two postero-lateral genital plates are long, and cause a considerable separation of the summits of the two hinder ambulacra from the other three. In flint casts there are strong indications of the presence of a sand tube like that in *Ananchytes ovata*.

Cardiaster granulosus grows to a considerable size. Moderately large and evidently adult specimens in the Museum of Practical Geology, to which they were presented by Mr. S. P. Woodward, measure 2 inches and $\frac{5}{12}$ths in length, the same in breadth, and 1 inch $\frac{1}{12}$th in height. Other examples have a greater height in proportion to the breadth, or a greater length in proportion to the width.

Locality and Geological Position. First observed as British by Mr. Samuel Woodward, who recorded it (*Spatangus cordiformis*) as rare in the Upper Chalk at Harford Bridge, and as common in the "Medial Chalk" at Swaffham and Thetford, all Norwich localities. The *Holaster æqualis* of Colonel Portlock has been already noticed as identical with it (the original specimens have been compared), and was found in the Chalk of Londonderry.

EXPLANATION OF THE PLATE.

Figs. 1. 2. 3. and 4. Different views of a Norwich specimen of *Cardiaster granulosus*.
Fig. 5. A flint cast; one of the original specimens of *Holaster equalis* of Portlock.
Fig. 6. Ambulacral and inter-ambulacral plates from the centre of the sides.

Fig. 7. A portion of the lateral fasciole, with the neighbouring surface, much magnified.

Fig. 8. Tubercles and granules of the dorsal surface, magnified.

Fig. 9. Tubercles and granules from under surface.

Fig. 10. Large tubercles and granules of the margins of the anterior sulcus.

LIST OF BRITISH SPECIES OF CARDIASTER.

1. *Cardiaster granulosus.* (Described in this Decade.)
2. *Cardiaster excentricus.* (Described in this Decade.)
3. *Cardiaster rostratus.* (Described in this Decade.)
4. *Cardiaster pygmæus*, FORBES. Ann. Nat. Hist. 2d ser., vol. vi. p. 444. (noticed only.)

C. *minutus, ovatus, ambitu cordato, ambulacris tuberculisque inconspicuis, dorso sub-carinato, ano alto.*

This little species is common in the Chalk of Dover, where good specimens have been found by Mr. C. F. Cockburn, and presented by that gentleman to the Museum of Practical Geology. The ovate outline, apparently smooth surface (under the lens scattered primary tubercles are seen among minute granules), simple and narrow poriferous avenues, strongly carinated anteal sulcus, subcarinated posteal segment, and high posterior truncation with the vent at the upper part, strikingly characterize it. A middle sized specimen measures $\frac{6}{12}$ths of an inch in length by $\frac{5}{12}$ths in breadth, and $\frac{4}{12}$ths in height. Its proportions vary considerably.

All the above are from the White Chalk.

5. *Cardiaster suborbicularis* of Defrance, Brongniart, and Goldfuss (under the genus *Spatangus*). This is the *Holaster carinatus* of Agassiz. In the Catalogue Raisonné this name is made synonymous with *Spatangus nodulosus* of Goldfuss and *Spatangus planus* of Mantell, but the former appears to me to be the *Holaster lævis* of Brongniart, and the latter to be perfectly distinct from either.

Of *Cardiaster suborbicularis* I have seen only one British specimen, which on comparison with French examples appears to be truly referable to this species. It is from the Upper Greensand of the neighbourhood of Osmington in Dorsetshire, where it was obtained by Mr. E. H. Bunbury, who presented it (as part of his fine cretaceous collection) to the Museum of Practical Geology.

6. *Cardiaster fossarius.* The *Spatangus fossarius* of Miss Benett. This is the *Holaster Greenoughii* of Agassiz. With us it occurs in the Upper Greensand of Warminster.

7. *Cardiaster bisulcatus.* In the Museum of Practical Geology there is a *Cardiaster* from the Greensand of Blackdown, remarkable for the small tubercles in proportion to its size, and the great width of the hinder lateral poriferous avenues. It seems to be identical with the *Holaster bisulcatus* described and figured by M. Albin Gras in his "Oursins fossiles de l'Isere," p. 62, pl. 4, fig. 7. 8. He obtained it from the Gault of Ravix.

8. *Cardiaster Benstedii*, sp. nov.

In the Lower Greensand of Maidstone several examples of an urchin apparently a true *Cardiaster* have been found, distinct from any of our other species. It may be characterized thus :

C. *late cordatus, subhemisphæricus, dorso rotundato, seriebus pororum omnibus angustis subequalibus.*

The anterior sulcus is strongly marked and wide below. The back is gently curved. The vent is medial in position as compared with the height. The poriferous avenues are all remarkably narrow, and the hinder ones as broad as the anterolaterals. The surface of the test is too imperfectly preserved to be described. Specimens have been presented to the Museum of Practical Geology by Mr. E. H. Bunbury and Mr. Morris.

October, 1852. EDWARD FORBES.

BRITISH FOSSILS.

ERRATUM.

Decade IV. Plate X.

For CARDIASTER CAUDATUS *read* CARDIASTER ROSTRATUS.

what convex.

The anterior ambulacrum is lodged in a deep sulcus with sharply angulated sides. The bottom of this furrow is rounded, and covered with minute granules but no tubercles. The ambulacral pores are inconspicuous; they become close-ranked in the upper portion. The uppermost portion is reflected on the back with a rapid curve, and includes about six of the vertical rows of pairs of pores. It joins the apical disk a little in front of the tips of the antero-lateral ambulacra. These are placed very far forward, and run down upon the most tumid portion of the body. In a large specimen as many as thirty pairs of pores may be counted in these rows, between the apex and the margin. The avenues are at the surface of the test, and the pairs of pores of their outer rows are a very little wider than the inner ones. The postero-lateral ambulacra are even less conspicuous; they diverge greatly from the antero-laterals, and form together a very acute angle. Their uppermost portion consists of closely set pairs of pores; on their posterior portions the pairs of pores become very indistinct.

The plates on the margins of the anteal sulcus are thickly studded with small primary tubercles, which are very numerous also on the cheeks, but become few and scattered on the dorsal surface. They are perforated, and placed on crenulated bosses. The fasciole is distinctly marked, passing under the vent, and continued on each side even over the cheeks. The vent is large and perpendicularly ovate, its widest diameter uppermost; the area in which it is placed is either quite plane or slightly excavated.

On the under surface the mouth is seen near the anterior extremity, in front of the widest portion of the test; it is comparatively small and transversely oblong, the hinder lip is highest. On the ambulacral portions of the base there are very few or no tubercles, but a considerable number, and those rather large, on the shield-shaped inferior portion of the odd interambulacrum. In all the specimens that I have seen the base is much abraded. Young examples are rather more elevated than old ones. In one of Mr. Rose's specimens, however, a flint cast from Swaffham, $\frac{10}{12}$ths of an inch in length, nearly the same proportions are shown as in an example of twice the size. The most perfect specimen, in point of completeness of outline, that I have seen, measures one inch and ten-twelfths in length, by one inch and four-twelfths in breadth. Its anterior extremity is one inch and three-twelfths, and its posterior nine-twelfths of an inch in height.

Locality and Geological Position· First observed by Mr. Rose of Swaffham, and communicated by him to Mr. Samuel Woodward, in whose Geology of Norfolk it was briefly noticed, and slightly but characteristically figured. It is recorded by these geologists from the Upper and Medial Chalk of Norfolk. Mr. Bowerbank possesses a fine flint cast showing the plates. This description is drawn up chiefly from Mr. Rose's original examples and Mr. Bowerbank's specimen, all kindly lent for the purpose, and from a fine, but imperfect, specimen presented to the Museum of Practical Geology by my friend Mr. C. F. Cockburn of the Royal Artillery, who found it in the White Chalk at Dover.

II.

CARDIASTER ROSTRATUS.

DIAGNOSIS. *C. testâ lateraliter compressâ, apice in rostrum elongatum elevatumque producto.*

For some time I was under the impression that this extraordinary and anomalous little urchin of which specimens were kindly communicated by Mr. Bowerbank, Mr. Wetherell, and Mr. Woodward, was the young of the *Cardiaster excentricus*, different as its outline is. The series of specimens of various sizes of the latter species shown me by Mr. Rose, (who has also found the kind now figured,) convinces me that it is necessary to regard this beaked and *Neæra*-like form of *Cardiaster* as distinct. All the examples are impressed with the same peculiarities. The number submitted to me has been seven, including fragments; and in addition to those lent for examination are two fine specimens, one of them nearly entire, found by Mr. Cockburn in the Chalk with Flints at Bostal Heath, near Plumstead, and generously presented by that gentleman to the Museum of Practical Geology.

The striking feature of this form is the rhomboidal profile which it exhibits in consequence of the obliquity of the anteal and posteal truncations, both inclining forwards at considerable angles. The anteal ambulacral sulcus is very deep, long, and narrow; it rises obliquely to a great height in consequence of the elevation of the apical disk upon a sort of beak. The genital plates are assembled just below its summit, which is notched by the turning over, as it were, of the anteal furrow. The details of the lateral ambulacra, in consequence of their being completely plane and very obscure, can with difficulty be distinguished. The rostrum bends forward slightly in its upper part. The summit of the back is more or less sharply carinated, and declines rapidly with a faint concave curve, until it terminates in the summit of the very oblique and rapidly declining posterior truncation, in the uppermost part of which, at rather less than the total height of the body, is the anus, placed at one end of a groove. The whole of the dorsal surface of the test is covered with granules interspersed with scattered minute tubercles, which become more numerous on the slightly tumid cheeks. The fasciole is strongly and distinctly marked, and passes from beneath the anus over the cheeks. The base is flattened, and, except on the ambulacral spaces, is strongly tuberculated. The mouth is very small and far forward.

The largest specimen which I have seen measures $\frac{8}{12}$ths of an inch in length of base; $\frac{6}{12}$ths in breadth; $\frac{4}{12}$ths in height at the anal truncation, and when perfect must have been $\frac{10}{12}$ths in height at the anteal sulcus.

Locality and Geological Position. In the Chalk with Flints of Kent and Norfolk.

Description of the Plate.

CARDIASTER EXCENTRICUS. Figs. 1-18.

Figs. 1. 2. and 3. Different views of a silicified specimen in the cabinet of Mr. Bowerbank.

Figs. 4. 5. and 6. Outlines of a large flint cast, very perfect, in the collection of Mr. Rose. This is the original of the figure in the Geology of Norfolk.

Fig. 7. Anterior extremity of a large specimen in which the test is preserved, in the cabinet of Mr. Rose.

Figs. 8. 9. Half grown example, somewhat crushed, in the cabinet of Mr. Wetherell.

Figs. 10. 11. and 12. Anterior and posterior views and side profile of small specimen in Mr. Rose's collection.

Fig. 13. Outline of a young example in Mr. Rose's cabinet. A flint cast.

Figs. 14. and 15. Details of the test and of the apical disk as exhibited on flint casts.

Fig. 16. Outline of the under surface.

Fig. 17. Tubercles and granules from a specimen in the Museum of Practical Geology.

Fig. 18. Cheeks, with a part of the fasciole.

CARDIASTER ROSTRATUS. Figs. 19-24.

Figs. 19. 20. and 21. Different views of a specimen from the chalk near Plumstead, presented by Mr. Cockburn to the Museum of Practical Geology.

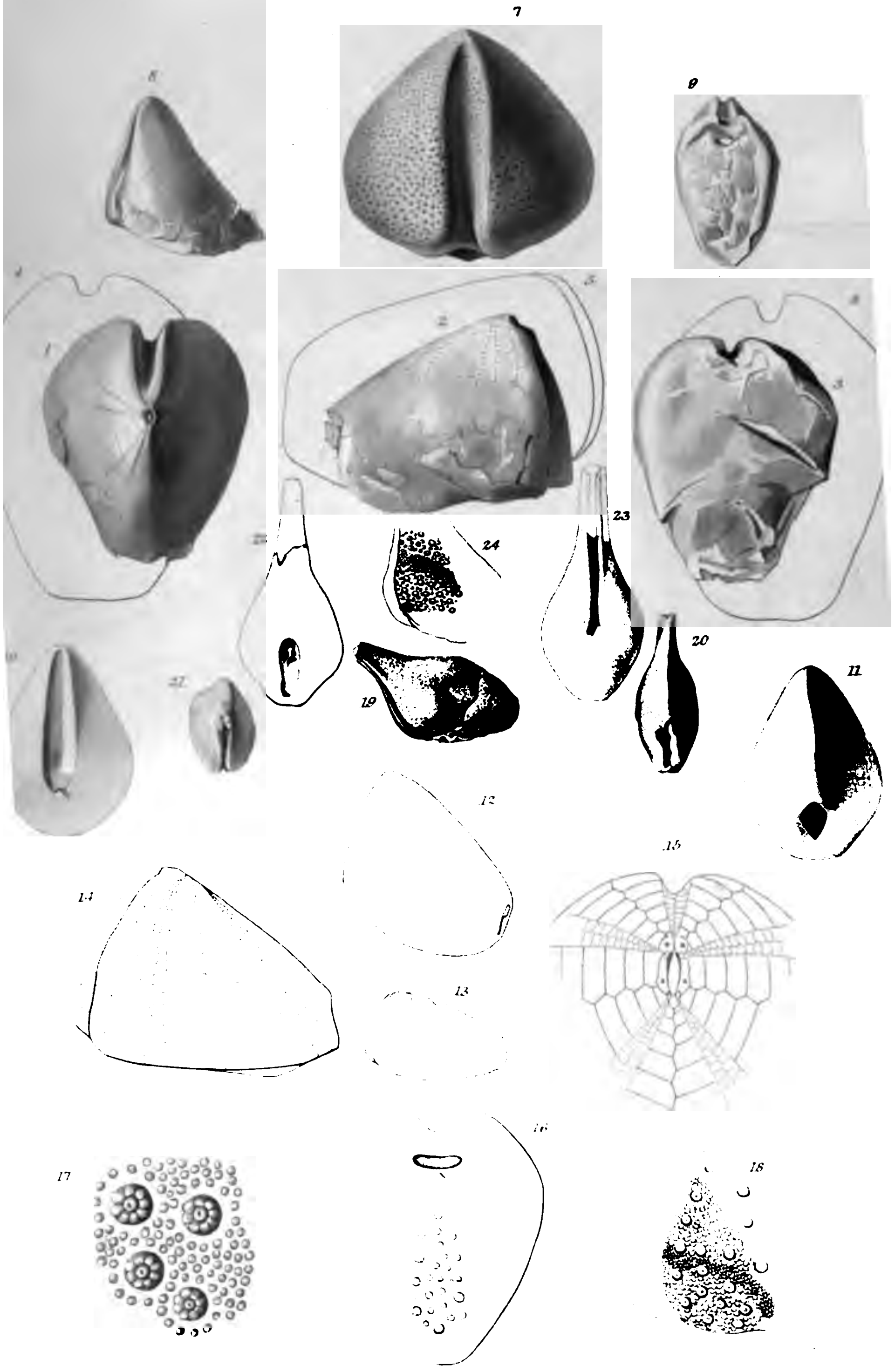
Figs. 22. and 23. Outline partly restored of a large specimen from Norfolk in Mr. Rose's collection.

Fig. 24. Cheeks and part of fasciole.

EDWARD FORBES.

October, 1852.

ological Survey of the United Kingdom. **CARDIAST**
(Cretaceous)



Figs 1-18 CARDIASTER EXCENTRICUS. *Rose.*
19-24 CARDIASTER CAUDATUS. *Forbes.*

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE V.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE:
PUBLISHED BY
LONGMAN, BROWN, GREEN, AND LONGMANS.
1856.

LONDON: PRINTED BY EYRE AND SPOTTISWOODE, HER MAJESTY'S PRINTERS.

BRITISH FOSSILS.

DECADE THE FIFTH.

In apologizing for the unavoidable delay which has taken place in the publication of this Decade, owing to the much lamented decease of Professor Edward Forbes, it is right to state that the materials left behind by him were scanty, and had been unfortunately mislaid a short time before his death. The first description only, that of *Solaster Moretonis*, had been fully written by him; of the others, we had here and there notes on the distinctive characters of the species, and of his views as to their synonymy or history. The plates, however, had been all engraved under his own eye, and the specific designations under which he wished the figures to stand, were recorded in the last edition of Morris's Catalogue. He had there also applied MS. names to a number of species to be described in the Decade.

In a few cases only it has been found necessary to alter some of these names; and this has been done in deference to an authority which would have been gladly admitted by Professor Forbes. To Mr. S. P. Woodward, of the British Museum, we are indebted for all the notes respecting these supplementary species; and he has also furnished full descriptions of three of the plates. With this valuable aid, and the friendly communications of Dr. T. Wright, of Cheltenham, we can present the Decade in nearly as complete a form as it would have possessed had our friend and Master lived to finish it. We miss, however, his lively remembrance of the living species, and his practical acquaintance with their variations,—deficiencies not to be supplied by reference to his published works.

Of the ten species figured three are new,—*Solaster Moretonis*, *Cidaris Carteri*, and *Pygaster conoideus*. Of the other genera, *Diadema*, *Echinopsis*, and *Echinus* present us with well-known types from the Oolitic rocks, which are continental as well as British. *Pyrina* is a rare genus in England, and in this, and the two figured species of *Pygaster*, we have excellent examples of that division of the *Cassidulidæ* in which the ambulacra are of uniform character throughout. Several genera of this type have been figured in the Decades. The *Pygaster semisulcatus* is a critical species, and its synonymy is now for the first time cleared up. *Hemiaster Murchisoniæ* is another instance of the same kind, and belongs to a large genus of closely allied species. The *Brissus Scillæ* is a Crag species still existing in the Mediterranean. None of these nine genera have before appeared in the Decades.

There are engraved plates sufficient for another fasciculus, upon which Professor Forbes left no memoranda, except the names of the species. These Plates will be published at a future period.

JOHN W. SALTER,
Palæontologist.

Geological Survey Office, Jermyn Street, London,
February 1856.

BRITISH FOSSILS.

DECADE V. PLATE I.

SOLASTER MORETONIS.

[Genus SOLASTER. FORBES, 1839. (Sub-kingdom Radiata. Class Echinodermata. Order Asteriadæ. Family Solasteridæ.) Body stellate, multiradiate, covered with fasciculated spines; avenues bordered by three sets of spines; suckers biserial. (CROSSASTER, Müller.]

DIAGNOSIS. *S. radiis numerosis* (30), *angustis, linearibus.*

REFERENCE. *Solaster Moretonis*, FORBES (1854), in Morris's Catal.; 2nd edit. p. 89.

Very few species of the genus *Solaster* are known in the seas of the passing epoch. *Solaster papposus* and *S. endeca* are both inhabitants of the European seas. They are many rayed star-fishes of considerable dimensions, and resemble in their shape the conventional figure of the sun. None had hitherto been found in the fossil state until the remarkable and unique star-fish now for the first time figured and described was procured by Earl Ducie. It was found in a fawn-coloured freestone belonging to the Great Oolite (?) at Windrush Quarry, in Gloucestershire.

It differs conspicuously from its living congeners in the great number of its rays and their linear contour. The details of its structure are such as leave little doubt respecting its generic position, and I do not feel warranted in constituting a new genus for its reception. If, however, the discovery of other specimens should show that the dorsal surface is furnished with simple and not paxillated spines, then the foundation of a new genus might be necessary.

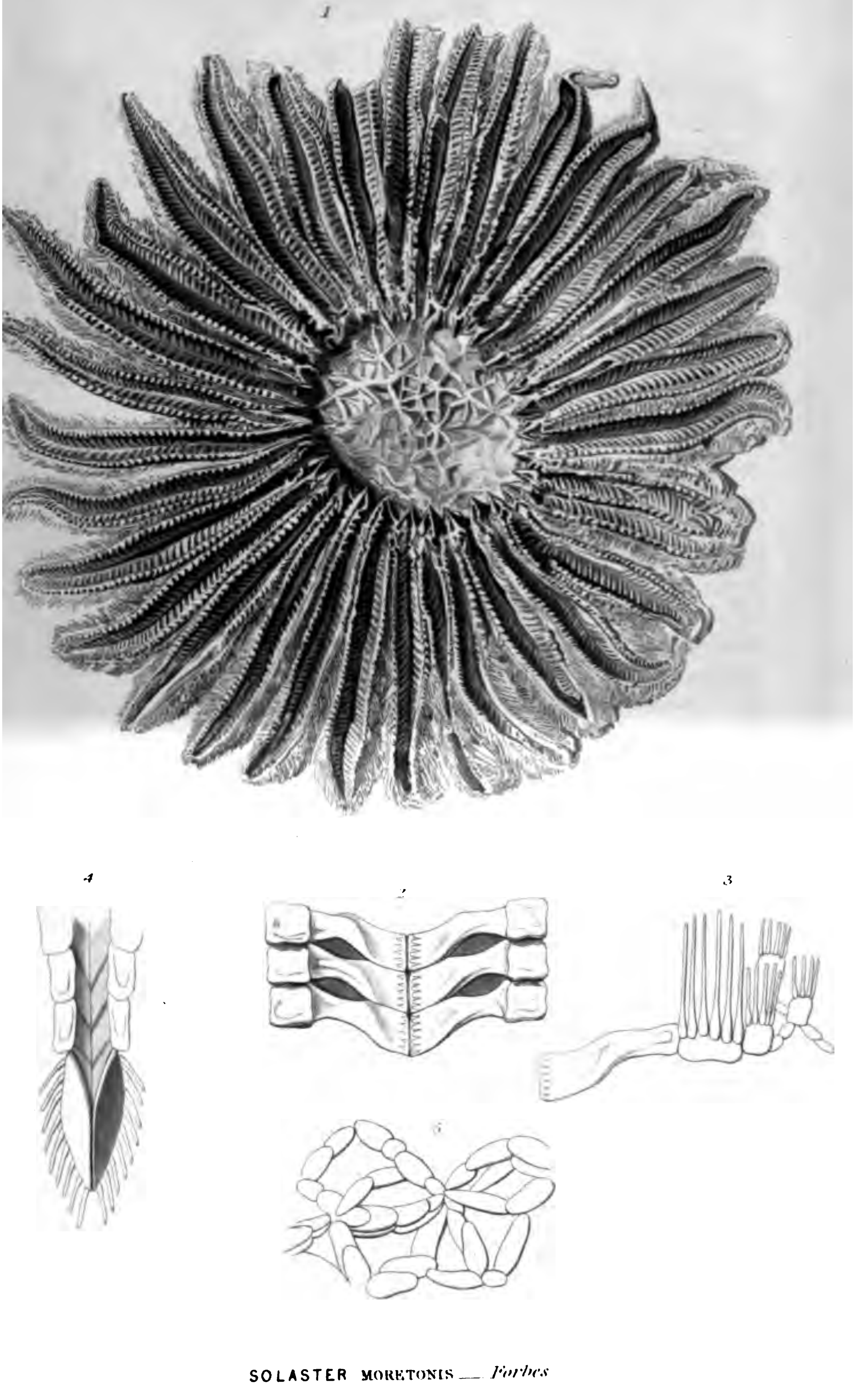
At first glance this beautiful and well-preserved fossil seems as if it were the head of a Crinoid, with outspread arms, crushed flat. A nearer inspection shows that it is really a star-fish, and suggests a close comparison between it and *Uraster helianthus*, a well-known many-rayed species from the Pacific coasts of South America. A still closer examination proves that it is not a member of the family of *Urasteriadæ*, a group distinguished by the presence of four rows of suckers in each ambulacral avenue, but belongs to one of the genera in which there are but two rows of ambulacral feet. The peculiar arrangement of the ossicles of the disk, which are perfectly preserved in the specimen, the forms of the ambulacral ossicula, the single series of interambulacral bones, the arrangement and shape of the spines on the border of the avenues, and of the ossicula at the basal angles of the arms, all indicate its probable position in the genus *Solaster*.

The diameter of the individual figured, measured from ray point to ray point, is somewhat more than 5 inches, the disk is 1 inch and $\frac{3}{12}$ across, and a ray is 2 inches long, and $\frac{1}{12}$ of an inch broad at its widest part. The average breadth of an ambulacrum is $\frac{2}{12}$ of an inch. There are thirty-three rays, in all of which the ambulacral portions as well as the borders are beautifully preserved. The extremities of some of the rays are partially turned over, but the portion of the dorsal surface thus exposed is obscured by crushed spines. The inner surface of the dorsal integument of the disk occupies the centre, all the ventral portions of that region having disappeared. The framework of the dorsal disk is for the most part excellently preserved. The skeleton in this region is composed of a number of rather stout and vertically compressed oblong ossicles overlapping each other slightly, arranged in a loose and somewhat irregularly reticular pattern. The connecting ossicula are most perfectly seen, the spiniferous ones being partially concealed by their supporters. Towards one side of the disk is a rounded impressed space with traces of a wrinkled surface. This I take to be the position and remains of the madreporiform tubercle.

The position of the vent cannot be clearly traced; a circumstance by no means surprising, considering the difficulty there is in observing the place of this orifice in the living star-fishes.

The arms are very narrow, and of a linear shape; their sides being parallel throughout the greater portion of their length. At the point of junction of the base of each arm with that of the next, is a pair of erect semi-circular, compressed, slightly sinuous, sharp-edged bones (the angle-ossicula). Their inner edges, *i. e.* those directed towards the mouth, approximate; their outer edges are divergent. Their upper edges spread outwards, but much less so than in the corresponding bones in the recent *Solaster pappposus*, and they are much more compressed and elevated. Along their outer margin are rows of slender spines.

SOLASTER (Oolitic)



SOLASTER MORETONIS — *Forbes*

Each avenue is composed of two series of ambulacral ossicles, about sixty in a row, their inner edges being minutely crenulated and accurately meeting along the centro-sutural line. These ossicles are shaped something like a dice box,* each divided into two more expanded portions and a central narrower part. The inner portion is flattened or slightly excavated, and somewhat rhomboidal, the outer elevated into a ridge. The middle and more contracted portion is carinated obliquely, and on the inner (proximal) side has a triangular groove. A similar groove occurs on the outer (distal) side, placed nearer the middle than the former. The sides of the ossicles are widely excavated for the purpose of forming the ambulacral perforation through which the soft suckers or ambulacral feet passed. The interambulacral ossicles are rather quadrate, and divided diagonally, though somewhat irregularly and lobe-like, into two portions, of which the inner or inferior portion is elevated, and the outer depressed. These ossicles change shape, and become narrower as they approach the buccal regions of the ventral disk. Their crests or elevated portions bear combs of long slender acicular spines, with bulbous bases; of these spines there are from four to six in each transverse row. The arrangement of the dorsal surface of the arms is too obscure in the few portions of those organs that are reversed to enable me to make out their details with certainty; but I think I can perceive pretty clearly the paxillated character of the spines, and that these bodies, forming the radiated or brush-like crowns of the paxillæ above described, are much shorter and stouter than the marginal spines.

Locality and Geological Position.—In the OOLITE of Windrush Quarry, near Northleach, Gloucestershire. (Collection of Earl Ducie.)

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* They are much less bent, even near the mouth, than in the recent *S. papposus*.—J.W.S.

DESCRIPTION OF THE PLATE.

Fig. 1. *Solaster Moretonis*, natural size.

Fig. 2. Magnified ambulacral ossicles.

Fig. 3. The same, with some interambulacral ossicles magnified,—the comb-like spines attached.

Fig. 4. Inner (proximal) portion of the ambulacrum, with its large angle-ossicula, and their spines.

Fig. 5. Reticular pattern of the ossicles of the disk.

E. FORBES (1854).

March 1856.

BRITISH FOSSILS.

DECADE V. PLATE II.

DIADEMA PSEUDODIADEMA.

[Genus DIADEMA. GRAY, 1835. (Sub-kingdom Radiata. Class Echinodermata. Order Echinida. Family Echinidæ.) Body circular, rather depressed; ambulacral areæ with two rows of primary perforate tubercles as large, or nearly as large, as those of the interambulacra; the latter with 2 or 4 rows of primary perforate and crenulated tubercles; spines long, cylindric, striated, and annulated.]

DIAGNOSIS. ***D.* 2–3 *uncialis, hemisphærica, depressa, tuberculis numerosis regulariter radiata; primariis in utrâque area binis, in ambulacro minoribus* (*in singula serie circa* 20) *in spatio altero majoribus* (*circa* 17), *secundariis parvis granulisque interpositis: disco anali parvo, rosaceo.***

SYNONYMS. *Cidarites pseudodiadema*, LAMARCK (1801), Anim. sans Vert., 1st edit. t. iii. p. 59. No. 17.; 2nd edit. 1840, vol. iii. p. 385. *Cidaris monilipora*, PHILLIPS (1829), Geol. Yorks., 1, 156. *Cidaris diadema*, YOUNG and BIRD (1822), Geol. Survey of Yorkshire, t. 6. f. 3. ***Diadema Lamarckii***, DESMOULINS (1837), Tab. Synopt., p. 316. No. 18. (*sec.* Wright). *D. ambiguum*, ib., p. 316. (*sec.* Agass. and Desor). *D. pseudodiadema*, AGASSIZ (1840), Echinod. Suisses, t. ii. p. 11. tab. 17–49, 50, 52, 53. AGASSIZ and DESOR (1846), Cat. Rais. des Ech., Annales des Sc., 3rd ser. vol. vi. p. 349. WRIGHT (1851), Ann. Nat. Hist., vol. viii. p. 271. [t. 12. f. 1.] COTTEAU (1852), Etudes sur les Ech. Foss. Yonne, p. 142. pl. 17. fig. 1. [*icon mala.*]

(*Diadema hemisphæricum*, AG. Prodr. p. 22. Cot. Ech. foss. p. 139, tab. xvi. fig. 5–9 ?) *Pseudodiadema hemisphæricum*, DESOR (1855), Synopsis, p. 68.

Of this beautiful Oolitic urchin, which is not uncommon in the Coral Rag, we have had the opportunity of figuring good specimens, through the kindness of Dr. Wright and Professor Morris. It is an excellent example of the genus, which has a great vertical range. Species of *Diadema* are found in all the secondary and tertiary formations, and others are still living in the Mediterranean, and in tropical seas.

The genus, constituted by Dr. Gray for the *Cidaris diadema* of Lamarck (*Diad. turcarum*), was formerly made by Prof. Agassiz to include those similar and very elegant chalk species now known by the name of *Cyphosoma*. None of these are yet figured in these Decades.[*] They differ essentially from *Diadema*, by having the tubercles imperforate, as it is called, or without a central depression; and as a character of habit may be distinguished by having the tubercles on the ambulacral area as large as those of the interambulacral, while in *Diadema* the latter are almost always of greater size. The present genus ranges through the whole of the secondary formations up to the present time; the *Cyphosoma* is confined to the chalk formations.

The numerous species of *Diadema* described by Agassiz and other authors fall, according to the Swiss naturalist, under three groups or subgenera, the characters of which are given in the "Catalogue Raisonné." In the first group, of which the living *D. europæum* is considered the type, the interambulacral areæ have but *two rows* of primary tubercles, without secondary rows. Of this type, *D. depressum*, Ag., and *D. mamillanum*, Rœmer, are British fossil examples, and the majority of the species in the genus are at present arranged in it. Of the second group the species here figured is a good example. It has, besides the two primary rows of tubercles, secondary rows of less size. In the third group (*Tetragramma*), the multiplication of the larger tubercles has proceeded still farther, there being four rows at least on each interambulacral space. *D. Brongniartii*, a cretaceous fossil, is a good British species of the type.[†]

Description.—Diameter, 2 inches 5 lines; height, 1 inch 3 lines; diameter of the mouth (exclusive of the notches), 11 lines. General form, subhemispheric; the upper surface depressed above, the inferior surface very much flattened. From the depressed apex the sides slope a little outwards to the rounded margin, radiated pretty equally by the five lanceolate ambulacra, which are very little, if at all, more prominent than the intervening spaces. They are furnished with two rows of primary tubercles, about twenty in a row, which are small near the apex, and increase in size towards the margin, where three or four become abruptly larger; all are perforate, and on crenulated bosses. Between them, for all the lower two thirds of the ambulacrum, there is a single row of small secondary tubercles, and a few granules also are interspersed. On the plates of the upper surface these granules surround the primaries, but on the lower ones are only occasionally to be met with.

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[*] A notice of some species of this genus, considered new by the late Prof. E. Forbes, will be found at the end of this Decade.

[†] Desor combines (in his recent work, 1855) the first and second of these groups in the section "*Pseudodiadema*," and he also separates those species which have the pores crowded above (*D. subangulare*, Agass., and *D. pentagonum*), under M'Coy's genus *Diplopodia*. (*See* Appendix.)

The primary tubercles in the interambulacral spaces are larger than those on the ambulacra, but not quite so many in a row (about sixteen or seventeen), and from about the upper third of the segment there are secondary tubercles, likewise perforated, but very much smaller. There is a single row of these outside the primaries, and a double row down the middle. These secondary tubercles are largest at the turn of the margin, and decrease rapidly in size above or below that point. Each plate, at least on the more prominent parts of the test, bears two or three secondary tubercles on each side of the primary one. Of these the most conspicuous are placed on a line with the primary tubercle, the others occupy the angles of the plates, and are interspersed with numerous granules, which only on the upper plates surround the primary bosses. These bosses are of a transverse broad oval form, and for the greater part of each row are confluent at the base. They are flat round their base, then rise steeply to the crenulated edge, which is divided by about fifteen notches, and support small strongly perforated tubercles. They increase very regularly in size outwards, and radiate regularly from the apex, instead of divaricating widely, as in the recent *D. turcarum*, and then converge rapidly on the under surface, so as to leave a depressed space between the ambulacral tubercles occupied by the pores. There are about seventy pairs of pores in each row, which are disposed in a single series, and run in nearly a straight line from the apex to the circumference; below this they undulate a little, and close to the oral margin about twenty pairs fall into ranks of threes.

Each pair of pores forms an ovoid, and is included in a ring, and an elevated tubercle or ridge separates the pores, forming as it were a handle across the elliptical space.

The apical disk is small compared with that of other species, in our largest specimens not half an inch across. It is composed of five obovate genital plates, and five minute ocular plates; the genital plates extend outwards much beyond the oculars; they are covered by large granules, and are perforated nearer the outer than the inner margin.

The right (anterior?) plate, which bears the madreporiform tubercle, is decidedly larger than the rest. The anus is roundish, not quite regular in shape. The mouth is larger than in our figure, measuring, from point to point of the ten deep notches, at least three fifths of the whole diameter. The notches are placed in pairs at the oral edge of the interambulacral spaces, their depth being about equal to their width apart, and those of each pair are considerably nearer to one another than to the neighbouring pair.

Our specimens shew no spines. They are, however, represented by Prof. Agassiz in the Ech. Suisses, t. 17. f. 51., as slender, cylindrical, solid, pointed at the ends, and finely striated.

Affinities.—There seems to be no other English species with which it can be compared, unless a somewhat more convex and smaller form which is said to occur with it in the Malton Oolite may be considered distinct. This species or variety has fewer (twelve) and rather more prominent interambulacral tubercles, and the secondaries between these are smaller and fewer. The ambulacra are a trifle narrower in proportion, and are somewhat more convex than the intervening spaces, while in the figured species there is no such difference; and as the primary tubercles are not so crowded in the rows, they are rounder and less oval than in *D. pseudodiadema*. The apical disk is very much the same, but there is a difference in the arrangement of the pores near the mouth, which can scarcely be due to age—only about eleven or twelve pairs of pores (instead of twenty) being formed into ranks of threes. Specimens of this in the British Museum and the Geological Survey Collections agree with *D. hemisphæricum*, Ag., as figured by Cotteau, and are in all probability French specimens from the Coral Rag.

On this species Prof. E. Forbes left a good many notes, which are embodied in the above description, and his views of the synonymy are correctly expressed here, as also in the second edition of Morris's Catalogue. He has quoted in his MSS. the reference to *D. Lamarckii* of Desmoulins (which Dr. Wright adopts) with a doubt, and remarks of Cotteau's figure, "that it represents a cast, and is not good in its details. The pores are especially confused. Unaccountably, too, perhaps by the erroneous drawing of the pores in Phillips's figure, Cotteau has referred *Echinus germinans* of Phillips (*E. perlatus* of this Decade) to his species." Agassiz and Desor, in the Cat. Rais., have done the same, though with a mark of doubt. The *D. ambiguum* of Desmoulins, according to these authors, is a synonym of the present species.

Locality and Geological Position.—CORAL RAG. Malton, near Scarborough.

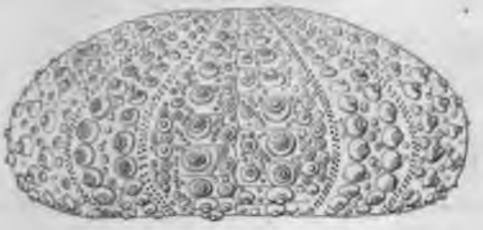
Foreign Localities and Range.—"CORALLIEN" of Besançon, canton de Soleure; St. Mihiel; La Rochelle.

J. W. SALTER.

January 1856.

ogical Survey of the United Kingdom.

DIADEMA
(Oolitic)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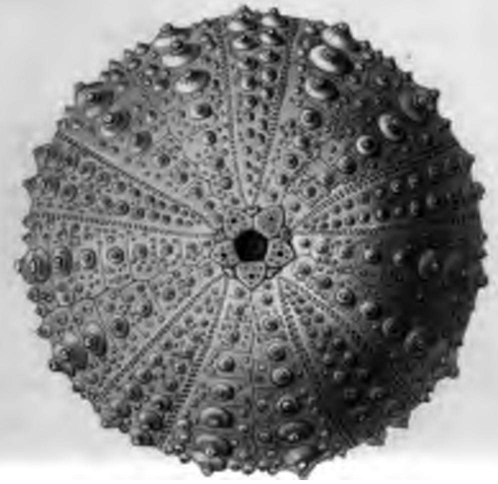
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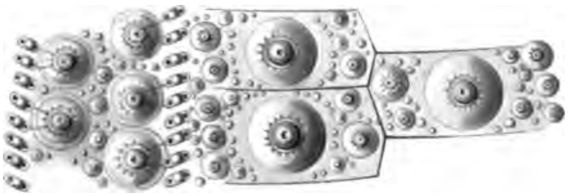
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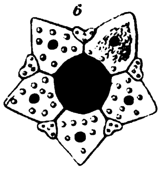
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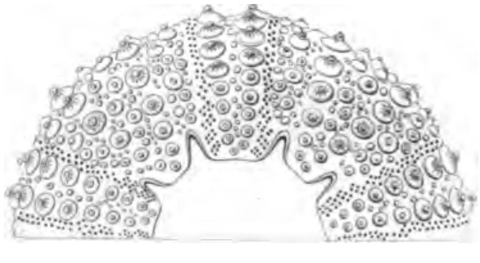
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DIADEMA PSEUDO-DIADEMA _ *Lamarck.*

DESCRIPTION OF THE PLATE.

Fig. 1. *Diadema pseudodiadema*, Lam., from Dr. Wright's specimen; the apical plates are restored from one lent by Prof. Morris.

Fig. 2. Side view of do.

Fig. 3. Part of the under surface, showing the deeply incised angles of the mouth and the pores, a few only near to the mouth, in ranks of threes.

Fig. 4. Portion of an ambulacral and of an interambulacral segment magnified; the pores in simple pairs, with a tubercle between each pair.

Fig. 5. Part of an ambulacral segment near the mouth, shewing the pores in ranks of threes, magnified.

Fig. 6. Apical disk, with 5 minute ocular plates, and 5 large and nearly equal ovarian plates; the right anterior one a little the largest, and bearing the madreporic tubercle.

Other British Species of Diadema.

In the second edition of Morris's Catalogue of British Fossils, Prof. Forbes had materially increased the list of the British species of this genus. Of the new species there recorded and referred to as described in this Decade, characters will be given, so far as the materials permit, by our friend Mr. Woodward. In the arrangement of the species he follows Desor, except that he regards his groups as subgeneric only.

Notes on British Fossil Diademas. By S. P. Woodward, Esq.

* JURASSIC SPECIES.

Section A. (*Pseudodiadema*, Desor.) Pores in single file.

1. *D. pseudodiadema*, Lam. Above described.

2. *D. Moorei*, Wright, Ann. Nat. Hist., 1854., pl. 12. f. 3.

Localities.—UPPER LIAS, Ilminster; also in Normandy.

3. *D. æquale*, Ag., Ech. Suis., t. 17. f. 36–38.

Locality.—" CORAL RAG, Steeple Ashton; M'Coy." Morris's Cat. 76. The original specimen, in the Cambridge Museum, is a fragment of *D. versipora* (*Diplopodia*); another, in the Brit. Museum, appears to be the real *D. æquale*, but its locality is not certain.

4. *D. depressum*, Ag., Cat. 8. Wright, Ann. Nat. Hist. 1851, vol. viii. t. 12. f. 2.

Localities.—BRADFORD CLAY, Cirencester. GREAT OOLITE, Minchinhampton. INFERIOR OOLITE, Crickley Hill and Dundry.

4 *a*. *D. armatum*, Forbes, MS. Morris's Cat., 76.

Locality.—INFERIOR OOLITE, Castle Carey, (not Gloucestershire), Somerset.

Represented in the Museum of Practical Geology by four small and imperfect specimens, undistinguishable from small examples of *D. depressum*.

5. *D. mamillanum*, Rœmer, Ool., vol. i. p. 26. t. 2. f. 1. *D. Davidsoni*, Wright (1854). Ann. Nat. Hist. vol. xiii. pl. 12. f. 2.

Localities.—CORAL RAG, Calne (Brit. Mus.); Redcliff, near Weymouth (Geol. Survey.)

The British specimens agree perfectly with specimens received from Dr. Rœmer, labelled " U. Coral Rag, Hildesheim, Hanover."

6. *Diadema homostigma*, Ag. (*sec.* Desor), Ech. Suiss. ii. p. 24, t. 17, f. 1–5.
Locality.—CORNBRASH, Stanton, &c., Wilts (W. Buy).

7. *D. vagans*, Phil. sp., Geol. Yorks., t. 7. f. 1.
Locality.—CORNBRASH, Yorkshire. (Morris's Cat. p. 77).

[The *Cidaris Bechei*, Brod. in Geol. Proc. vol. ii. p. 208 (not Geol. Tr. 2. ser. 2. t. 4. f. 5.), from the LIAS of Lyme Regis, was considered a *Diadema* by Prof. Forbes. The original specimen is in the Mus. Geol. Soc. From the condition of the specimen it would be quite indeterminable, but comparison with better examples developed by Dr. Wright shows it to be an *Echinopsis*.]

8. *D. Bakeriæ*, Woodw.

Body sub-pentagonal, depressed; lat. 16, alt. 7 lines; diameter of buccal opening 7 lines, anal 4 lines; primary tubercles prominent, in 2 rows of about 13 each, on all the areas; bosses crenulated; interspaces sparingly granulated, becoming bare above; pores in single file.

Locality.—CORNBRASH, Caistor, Northamptonshire. Collected by Miss Baker. (Coll. Brit. Mus.)

[The *Diadema minimum*, Ag., of Morris's Catalogue (*Diadema minuta*, Buckman), is an *Acrosalenia*, and was first described by Quenstedt under the name of *Cidarites criniferus*.]

9. *D.* "*subangulare*," Ag., Ech. Suisses, iv. 19. t. 17. f. 21, 22. (not of Goldfuss). *Cidaris versipora*. Woodw. MS. Morris's Cat. 1st edit. p. 50. Bronn, Index, p. 301.

Localities.—CORAL RAG, Calne and Hillmarton, Wilts; Farringdon, Berks.

There are two varieties of this species; one with the upper surface evenly inclined all round, the other tumid at the angles and depressed in the centre above. The spines are like those of *D. pseudodiadema*. The figure given by Agassiz agrees with a Swiss specimen in the Brit. Mus., and differs from the British examples in having fewer and more prominent primary tubercles, especially on the ambulacral areas, (viz. 11 instead of 13 to 16 in each row), and the ambulacral rows are not so widely separated by a finely granulated space.

We cannot agree with M. Agassiz in considering either of these forms referable to the "*Cidarites subangularis*" of Goldfuss (Petr. 1. 122. t. 40. f. 8.) German specimens, agreeing with Goldfuss's figure and description in the presence of only a single series of pores, are in the British Museum.

Section B. (*Diplopodia*, M'Coy), Pores crowded above and below.

10. *D. pentagonum* (*Diplopodia*), M'Coy, 1848, Ann. Nat. Hist. p. 412.

Locality.—GREAT OOLITE, Minchinhampton. (Woodw. Mus., Brit. Mus., &c.)

In this little species the pores are crowded at the ends of the ambulacra, as in *D.* "*subangulare*;" the character has not been considered of generic importance by M. Agassiz or Prof. Forbes, either here or in the cretaceous and recent species, but it has been adopted by M. Desor.

* * CRETACEOUS SPECIES.

Section A. Primary tubercles in two rows; pores in single file. (*Pseudodiadema.*)

11. *D. ornatum*, *Cidarites*, Goldfuss, Petr. t. 40. f. 10. (Forbes, in Mus. Pract. Geol. and Morris's Cat. 2nd edit.) *Cyphosoma Milleri*, part, Forbes, in Dixon, Geol. Sussex, pp. x. and 340, pl. 25, f. 17. (Mus. Bowerbank.)

In the first edition of Morris's Catalogue this name was introduced, at my suggestion, for the Warminster fossil, afterwards considered distinct and named *D. Benettiæ*.

Prof. Forbes, however, still referred to Goldfuss's species a specimen from the Grey Chalk of Dover, presented to the Museum of Economic Geology, by E. H. Bunbury, Esq., M.P.

This specimen is circular, and measures 14 lines in diameter, by 6½ in height; the upper opening is pentangular, and 6 lines across: the mouth only 4 lines, and very deeply sunk; the primary tubercles are more prominent than in *D. Benettiæ*, diminishing in size below, but not much upwards; the areolæ are radiated; the interambulacral tubercles are 12 in each row, divided by two rows of irregular granules, separating above and leaving bare channels; these areas are bordered below by two rows of accessory tubercles; the ambulacral tubercles are like the others, in two rows of 12 each, and nearly as large, converging above; the pores are close together above, but towards the circumference they are separated by conspicuous tubercles, or groups of granules, which gives them a straggling appearance, and makes them difficult of detection.

A second example of this *Diadema*, presented to the British Museum by Daniel Sharpe, Esq., has 14 tubercles in each row, and Mr. Bowerbank's example, referred to above, has 16–17 primary tubercles, which are consequently smaller and more crowded. A specimen in Mr. Mackie's cabinet is more elevated, and remarkably contracted at the base: it measures 13½ lines in diameter, and 7½ in height.

Locality.—Chalk Marl, Dover. (Mus. P. Geol., Brit. Mus. &c.)

12. *D. Benettiæ*, Forbes, Morris's Catalogue, 2nd edit. 1854. (*Cidarites ornatus*, Goldf., Petr., t. 40. f. 10.?) Desor, Synopsis, p. 12.

Body circular, inflated, depressed; lat. 14, alt. 6 lines (sp. maj.); apical disk large (15½ lines diam.), pentagonal; oral opening small (4 lines), deeply sunk; ambulacral tubercles as large as the interambulacral, in two distinct rows of about 15 each, separated by a double row of minute tubercles and granules; interambulacral tubercles in two primary rows of about 14 each, separated by a wide median space, unequally granulated, which becomes smooth above, and bordered by similar spaces, in which a few small tubercles are developed. The areolæ are sometimes radiated. Pores in regular distinct rows; those of the circumference with a small tubercle between each pair.

This species, abundant in the Upper Green Sand of Warminster, was dedicated by Prof. Forbes to the late Miss Etheldreda Benett, of Norton House, authoress of the "Catalogue of Wiltshire Fossils" (1831). In the first edition of Morris's Catalogue it was recorded as *D. ornatum*, Goldf., at my suggestion; and in the second edition, both names appear for the one species. As we have no authentic examples of *D. ornatum*, it is impossible to say in what respect it differs. M. Michelin has, however, communicated to Dr. Wright a specimen labelled "*D. ornatum*, Goldf.—Cap la Hève," which is undistinguishable from the Warminster specimens of *D. Benettiæ*.

Localities.—Upper Green Sand, Warminster: Durdle Cove, Dorset.

13. *D. Barretti*, Woodw.

Circular, depressed; lat. 11, alt. 5 lines; pairs of pores in single file throughout; *ambulacral* tubercles as large as interambulacral, in 2 distinct rows of 12 each, divided by a double row of granules margining the plates; *interambulacral* tubercles in 2 principal rows of 11–12 each, separated by 4 rows of granules, which partly surround the tubercles of the circumference and 2 secondary rows of 8–9 rather smaller tubercles; *base* concave; *apical* opening moderate, pentangular.

Differs from "*D. Benettiæ*," Forbes, and from *D. tenue*, Ag., in the development of secondary rows of interambulacral tubercles.

Locality.—Upper Green Sand, Cambridge. (Coll. Brit. Mus., and of Jas. Carter, Esq.)

14. *D. Bonei*, Forbes, Morris's Catal., 2nd edit. 1854.

Circular or slightly pentagonal, depressed; lat. 9, alt. 4 lines; base rather flat; ambulacral tubercles rather prominent, as large as the interambulacral, in 2 rows of about 10 each, close together, separated only by a zigzag line of small granules; interambulacral tubercles also in 2 rows of 10 each, with accessory rows of about 6 small tubercles outside. This urchin agrees with a specimen from M. Michelin, labelled (erroneously) "*D. subnudum*, Villers sur Mer;" it is perhaps the *D. Michelini*, Desor, Synopsis, p. 72.

Locality.—This species is rather less abundant than *D. Benettiæ* in the Upper Green Sand of Warminster, and never attains an equal size. It has a more spinose appearance, owing to the closer approximation of the ambulacral tubercles.

Note.—*D. rotatum*, Forbes, l. c., is the *Cyphosoma difficile*, Ag., and *D. M'Coyi*, Forbes, (*D. rotulare*, M'Coy, not Ag.), does not differ from it in any respect.*

15. *D. Rhodani*, Ag., Ech. Suisses, t. 16. f. 16–18.

Locality.—"Upper Green Sand, Blackdown, M'Coy," (Morris's Catal. p. 77.) The locality requires confirmation.

16. *D. Desori*, Forbes. (Syn. *D. Rhodani*, Ag.?)

Circular, depressed, convex above, concave beneath; lat. 10, alt. 4½ lines; apical disk small (lat. 3½ lines), pentagonal; ambulacra sinuous; tubercles in two rows of 10 or 11 each in all the divisions, those of the upper surface (3 of each row) minute, with very small bosses and areolæ, the interspaces minutely and uniformly granulated; marginal tubercles 2 or 3 in each row, large and prominent; base with accessory rows of tubercles on each side, and in the centre of each division; the whole small, subequal, and closely ranged.

The solitary specimen in the Museum of the Geological Survey, upon which this species was founded, was at first identified with *D. Rhodani*, Ag., but afterwards, probably with the approval of M. Desor himself, considered distinct. Compared with Agassiz's figure, and with an authentic example of *D. Rhodani* in the Brit. Museum, it differs in the size and form of the apical opening, and in the larger number of small tubercles on the upper aspect, thus giving a greater extent of uniformly granulated surface. Several other specimens in the collections of Mr. Cunnington and Mr. Sloper of Devizes have been examined, and show that the species is liable to considerable variation.

Locality.—Upper Green Sand, Warminster.

17. *D. pustulatum*, Forbes, l. c.

Sub-pentagonal, depressed, concave beneath, convex above, slightly inflated at the angles; lat. 14, alt. 6 lines; ambulacral tubercles in 2 distinct rows of 14 or 15 each, with 3 rows of small accessory tubercles (5 or 6 in each) below; interambulacral tubercles 13 or 14 in each row, with 6 accessory rows of small unequal tubercles beneath; tubercles largest at the circumference, becoming gradually smaller above and below; areolæ of the upper tubercles very small, interspaces uniformly granulated.

This species resembles M. Agassiz's figure of *D. Rhodani* even more than the last; compared with the specimen from the Perte du Rhone, it differs in the greater number and regularity of the rows of tubercles, the wider space between the ambulacral rows, the more densely granulated interspaces, and the greater number of accessory tubercles beneath. It is to be feared that the discovery of more specimens will not increase the validity of these differences.

Locality.—Upper Green Sand. (Craie chloritée), Chardstock. Presented to the Mus. Pract. Geology by E. H. Bunbury, Esq., M.P.

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* It has been placed in the genus *Glypocyphus* by M. Desor (Syn. p. 104), from which it differs totally in the character of its apical disk.

18. *D. tumidum*, Forbes, l. c.

Circular, inflated; lat. 9, alt. 5 lines; ambulacra straight; tubercles numerous, small, subequal, those of each division in 2 distinct rows; areolæ small, slightly radiated; ambulacral tubercles separated by a double row of granules; interambulacrals bordered by a few very small accessory tubercles; interspaces granulated, becoming quite bare near the apical opening. (Spines slender, solid, smooth. *Coll. Bowerbank.*)

Locality.—CHALK MARL of Dover. Chlor. marl. Somerset. (Coll. Wright; Tennant.)

The original specimen was presented to the Museum of the Geol. Survey by Edwd. Clarke, Esq., and stated to be from the GAULT of Folkestone. It is partly incrusted with pyrites, and filled with a matrix of what appears to be GREY CHALK. A better example of the same species in the Brit. Museum, undoubtedly from the Grey Chalk of Dover, has 12 or 13 tubercles in each row.

19. *D. Carteri*, Woodw.

Circular, tumid; lat. 10, alt. 6 lines; pairs of pores in single file; *ambulacral* tubercles as large as the interambulacral at the circumference, becoming much smaller above and below, in 2 close rows of 11 each, alternating; *interambulacral* tubercles 12 in a row, separated by a moderately wide granulated space, and flanked by rows of about 6 secondary tubercles externally, on the under side. *Base* concave; apical opening small.

Closely related to *D. tumidum*, Forbes. The ambulacral bosses are closer together, and the secondary rows of interambulacral tubercles more developed.

Locality.—UPPER GREEN SAND, Cambridge. (Coll. L. Barrett, and of Jas. Carter, Esqrs.

Section B. Primary interambulacral tubercles in 4 rows; pores in double series at the summit. (*Tetragramma*, Agassiz.)

20. *D. variolare*, Alex. Brongniart, 1834, Env. Par. p. 152. pl. M. f. 9. (*sec.* Forbes.) Syn. *Cyphosoma Milleri*, Forbes, in Dixon, Geol. Sussex, pl. 25. f. 17. (Mus. Bowerbank.)

Localities.—Specimens agreeing pretty well with M. Agassiz's published *cast* occur in the CHALK MARL of Dover (Brit. Mus. and Mus. Pract. Geol.), but it is impossible to ascertain what species was intended by M. Brongniart's figure and description, without reference to the original specimen.

It is rather singular that in Morris's Catalogue (p. 77.), we are referred for a representation of this species to Agassiz's figure of *D. Brongniarti*, whilst Bronn (Index, p. 1261.) and D'Orbigny (Prodrome, 2, p. 142.) quote Brongniart's figure of *D. variolare* in illustration of Agassiz's *D. Brongniarti*. Bronn also quotes Goldfuss's *Cidarites variolaris*, which is a *Cyphosoma*, and D'Orbigny places both species in the *Gault*.

21. *D. Brongniarti*, Ag., Ech. Suiss., t. 14. f. 4—6.

Localities.—GREY CHALK, Dover (Brit. Mus.). Chloritic Marl, Maiden Bradley, Somerset (Geol. Survey). These specimens have been compared with typical examples from the Upper Green Sand of the Perte du Rhône. In the recently published Synopsis of M. Desor, this species is accidentally placed in the genus "*Pseudodiadema*," amongst the species with pores in single file, whilst *D. variolare* is placed in the genus *Diplopodia*.

22. *D. Mackiei*, n. sp.

Inflated, depressed; lat. 24 lines; oral opening deeply sunk, lat. 6 lines; apical opening pentagonal, 7½ lines; ambulacral pores crowded above; primary tubercles not diminishing sensibly above, but decreasing regularly below; ambulacral tubercles in two rows of 17 each, *at wide intervals above*, the rows separated by a continuous granulated space; interambulacral tubercles *in* 6 *principal rows*, bordered at the circumference by accessory rows, the central space wide, granulated, and tuberculated, becoming bare and channelled above; spines slender (less than a line wide), solid, finely striated. A still larger specimen, in M. Bowerbank's cabinet, measures 2½ inches across.

Locaility.—Grey Chalk, Dover. (Coll. S. J. Mackie, Esq., and Bowerbank).

23. *D. subnudum*, Ag., Cat. Echin., p. 46. (Forbes.)

Sub-pentangular, depressed; lat. 10½, alt. 4 lines; base flat; apical opening pentangular, its diameter 4 lines; ambulacra straight, widening and confluent above; the pairs of pores in a compact double series as far as the fourteenth, a few next the mouth arranged in threes; primary tubercles small, subequal, those of the ambulacra in 2 close rows of 15 or 16 each, diminishing gradually from the circumference, and becoming very minute upwards; interambulacral tubercles in 2 principal rows of 11 or 12 each, diverging upwards, surrounded by rows of granules below, and divided by a bare space above; outer rows shorter, of 6 or 7 tubercles each.

Locality.—This species, which closely resembles the Oolitic *D. subangulare*, Ag., is one of the less common forms met with in the Upper Green Sand of Warminster; there are two specimens in the collection of Dr. Wm. Smith (Brit. Mus.); and several in the Museum of the Geol. Survey. It is more abundant, and attains a larger size in the chloritic marl of Somersetshire; specimens in Dr. Wright's collection measure 13 lines in diameter, and have 6 rows of interambulacral tubercles, nearly equal in size at the circumference, like *Diplopodia Roissyi*, Desor. In the collection of Dr. Wright is a specimen of this urchin from the U. Green Sand of France, labelled "*D. variolare*, Br.," by M. Michelin.

23 *a*. *D. dubium*, Albin Gras, Oursins Foss. Suppl., p. 3. f. 21—23. (Forbes).

The specimens from Farringdon agree in their general character with a cast of the typical *D. dubium*, in Dr. Wright's cabinet, and may be identified with *D. sub*[illegible], Ag.; to which species M. Desor unites the *D. dubium*, but their state of preservation does not admit of very exact comparison.

Locality.—Lower Green Sand of Farringdon, Berks. (Brit. Mus.)

24. *D. Mackesoni*, Forbes, l. c.

Sub-pentagonal, depressed, inflated at the angles; lat. 18, alt. 7 lines; apical opening pentagonal, lat. 7 lines; ambulacra straight and rather wide, scarcely meeting above; pores obliquely two-ranked as far as the fourteenth pair; ambulacral tubercles divided by 2 rows of granules, and not diminishing much upwards; interambulacral tubercles in 4 rows, the principal rows parallel, the outer rows shorter by 3 tubercles above.

Locality.—From the Lower Green Sand (Kentish rag) of Hythe, presented to the Museum of the Geol. Survey by Mr. H. B. Mackeson, Copt Pt. Folkestone. (Coll. Mackie). It is nearly related to *D. subnudum*, with which, as the better preserved species, it has been compared.

25. *D. Ibbetsoni*, Forbes, Morris's Cat., p. 76.

Circular, depressed, lat. 9, alt. 3½ lines; apical opening 3, oral 3½ lines across; base tumid; primary tubercles rather large and close-ranked, ambulacral 11–12, the 3 uppermost minute; interambulacral tubercles in two principal rows of 11 and 12 each, and two external rows, shorter by 3 or 4 tubercles above, and diminishing rapidly beneath; pores obliquely two-ranked above, as far as the ninth pair, and again near the mouth.

This species attains a larger size, but the examples hitherto obtained are fragmentary and obscure; the small specimen described is very distinct from Dr. Wright's *D. Autissiodorense*, which has only two rows of interambulacral tubercles, and wide miliary zones. It is more like *D. Mackesoni*, but is more closely tuberculated above.

Locality.—Lower Green Sand. Atherfield, Isle of Wight. (Mus. Geol. Soc.)

26. *D. Autissiodorense*, COTTEAU, Cat. Méth. (1851), p. 5. *sec.* Wright, Ann. and Mag. Nat. H. (1852), vol. x. p. 91.

Locality.—LOWER GREEN SAND, "Cracker-rock," Atherfield, Isle of Wight. (Coll. Wright.)

Section C. Spines tubular, annulated. (*Diadema.*)

27. *Diadema*, sp.

This specimen consists of numerous scattered plates, with portions of the dental apparatus, and fragments of above 100 spines. Nearly all the plates exhibit only the smooth internal surface; the ambulacral pores are in single file, becoming a little crowded near the oral extremity; the interambulacral tubercles appear to have formed more than two rows, and are of unequal size; they are distinctly perforated and crenulated. The spines are *tubular*, longitudinally striated and annulated (as, *e. g.*, in the recent *D. calamaria*); the annulations are often oblique, and that nearest the articular end is very prominent. These spines are cylindrical and slender; the largest fragment measures 15 lines, with a diameter of half a line, and may have been 3 inches long when perfect.

Attention has been directed to this specimen by Mr. L. Barrett, F.G.S., who ascertained that a spine from it had been inadvertently figured in pl. 10, f. 15, of Decade 3. The figure is very bad, and the oblique annulations are described as *spirals* (*Micraster*, Decade 3, p. 4). Several specimens, precisely similar, are in the cabinet of Mr. Bowerbank, one of them has been figured in Dixon's Geol. Sussex, pl. 25, f. 8, as the spine of a *Cidaris*.

Locality.—UPPER CHALK, Kent. (N. T. Wetherell, Esq.)

S. P. WOODWARD.

March 1856.

BRITISH FOSSILS.

DECADE V. PLATE III.

ECHINOPSIS ROTATA.

[Genus ECHINOPSIS. Agassiz. (Sub-kingdom Radiata. Class Echinodermata. Family Echinidæ.) Body inflated, depressed, or sphæroidal; primary tubercles in each area small, perforated, and borne on plain, not crenulated, bosses; pores in single file, or in oblique ranks of threes; mouth but slightly notched.]

[Sub-genus *Pedina*, Agass. Pores in ranks of threes.]

Diagnosis. ***E. sesquiuncialis, rotunda vel subpentagona, granulosa, tuberculis primariis* 10-*radiatis muricata, ambulacralibus distincte binis, parvis; interambulacrorum (in serie singula* 13-14) *superne majoribus conspicuis, infra arctius aggregatis minoribus: secundariis, nonnullis ad orem exceptis majoribus, minutis; ore modico.***

Synonyms. *Pedina rotata*, Agassiz (1840), Echin. Suiss., pl. 15. fig. 4–6. *P. ornata*, ib., fig. 7. [*Diadema micrococcon*, Desmoulins (1837), Tabl. Synon. des Echin., p. 314.] *Pedina rotata*, M'Coy (1848), Ann. Nat. Hist. 2nd ser. vol. ii. p. 210. *P. rotata*, Wright (1851), ib., vol. viii. p. 273. *Echinopsis rotata*, Forbes (1854), in Morris's Catalogue, 2nd edit. p. 78. [*P. granulosa*, Ag., Cat. Raisonné (1846), Ann. Sc. Nat., vol. vi. p. 370. *P. Gervillii*, Ag., ib., 371. *sec.* Wright.]

To the excellent description given by Dr. Wright in the eighth volume of the Annals of Natural History, there is scarcely anything to add; and as that author and Professor Forbes have both abstained from citing their names, we do not feel justified in associating with this species the other very closely allied forms, viz., *P. sublævis* and *P. aspera*, which Prof. Agassiz had first separated in his Echinod. Suisses, and afterwards, in the Catal. Raisonné, united with *P. rotata*. Nor would it be proper here to raise a question as to the propriety of uniting *Echinopsis* with the genus *Pedina*. The essential character supposed to distinguish the latter genus, viz., having the bosses of the tubercles crenulated, has proved to be a mistake.* And as Prof. E. Forbes lately published, as an *Echinopsis*, a tertiary species agreeing in all the main characters with *Pedina*, he has in that way distinctly recorded his opinion that the two groups should form but one genus.

Description.—Diameter, an inch and a quarter; height, three-quarters of an inch. "The test of this urchin is circular, but in some specimens a fullness of the ambulacral areæ gives it a slightly pentagonal outline; it is particularly tumid at the circumference, and depressed at both poles. The ambulacral areæ have two rows of small tubercles disposed along their outer border, between which rows small granules are arranged with less regularity. The interambulacral areæ are twice and a half the width of the ambulacral, and furnished each with a double range of primary tubercles, extending from the mouth to the ovarian plates." These primaries are prominent, and give a rough character to the upper surface, where they are larger and less crowded than on the lower. They radiate in ten conspicuous rows, each pair of rows about 30° apart, and on each side of them are very irregular secondary rows, and numerous miliary granules, which surround the areolæ and cover the whole surface. In a very good specimen, lent us by Dr. Wright, there are thirteen plates in an interambulacral row. In the upper ones the length is equal to the breadth, but its proportion decreases towards the periphery, on which the plates are nearly three times as broad as they are long (fig. 4). Each plate bears a perforated primary tubercle, which is placed on a small smooth boss near the lower margin, and, besides, seven or eight much smaller secondary tubercles, perforated and surrounded by the granules. The tubercles on the ambulacral areæ are no larger than the secondaries on the other portions. They are numerous, about thirty-three or thirty-four in a row, perforate, and all of nearly equal size. One or two are here and there larger than the others, but not in any regular order.

"The poriferous avenues are narrow, in which the holes are thickly set in triple oblique pairs," more oblique above (see fig. 4.) than on the under surface, where the threes are so placed that the pairs appear to be alternately 1, 2, 1, 2, the lowermost of the three coming into line with the uppermost of the next rank, and the middle one standing by itself. Each pair is distinctly surrounded by an oval ring, which disappears when the surface is abraded.

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* In the typical group, represented by *Ech. elegans*, the pores are not arranged in triple rows; and if to this be added the small size of the genital plates, (which, with the oculars, form a sort of ring round a large anal aperture,) and the very slight indentations of the edge of the mouth, there would seem to be good reason for separating from them *Pedina*, which has triple ranks of pores, and for making the latter a sub-genus at least.

The mouth is small, and does not occupy more than a third of the diameter, even including the short notches. These are ten in number, and not far from equidistant; the pair beneath the ambulacral spaces, however, are placed closer to each other than to the next pair: the oral margin between the notches is straight, not rounded.

The apical disk is often well preserved, probably from its shape. It is small, of five nearly equal heptagonal plates, the blunt points of which form re-entering angles upon the interambulacral space, and the madreporic plate is scarcely at all larger than the others. Between these are five moderately large oculars of pentagonal form, and these, as well as the genital plates, have the perforation placed outside the middle of the plate. The anal aperture is scarcely wider than one of the genital plates; it is more angular than in our figures.

Affinities.—Between our British fossil and Agassiz's description and figure of the *P. rotata* there seems to be a very close similarity. Perhaps the figure in the Ech. Suisses may represent a species with more numerous interambulacral plates on the upper half, but it agrees with ours in the tumid form, the shape of the ambulacral areæ, and their close-set and equal tubercles. The latter character we think will justify the union of *P. ornata*, Ag., with it, but will at once separate *P. rotata* from the *P. sublævis* or *P. aspera*, Ag., in which only every third or fourth of these tubercles is enlarged, so that there is a zig-zag row of conspicuous tubercles down the area, instead of the close-set double series of small ones. Added to this, the two Swiss species just quoted are decidedly more depressed than *P. rotata*, and the secondary tubercles, instead of being scattered, are arranged in intermediate rows on the interambulacra.

History.—M. Agassiz quotes in his Catal. Rais. the name of *Diadema micrococcon* of Desmoulins for this species. As that author published his Tableau Synonymique des Echinides in 1835,* this name would have priority, had his short description, unaccompanied by figure or locality, been sufficient to recognize the species. It was well figured, but scarcely sufficiently described in the Ech. Suisses, where the more equal character of the ambulacral tubercles and the greater height of the test are shown in contrast with the depressed form of *P. sublævis*, Ag. But in the Catalogue Rais.

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* Actes de la Soc. Linn. de Bordeaux, tom. 7.

the author seems to have doubted the propriety of separating these closely allied species, and he has accordingly thrown together not only the *P. rotata* and the *P. ornata*, in which view we think the English specimens will bear him out, but also the more flattened form *P. aspera*, from the oolites of France and Switzerland (Oxfordien, "terrain à chailles"), or, as it appears when partly abraded, *P. sublævis*.

As explained above, we regard these as distinct, and in this opinion we have the concurrence of Mr. S. P. Woodward in support of what appears to have been the late Prof. E. Forbes' view. More lately (1848) Prof. M'Coy quoted this fossil as from the great oolite of Minchinhampton, probably an error, as Dr. Wright has since pointed out in the careful description above cited. We have seen his specimen at Cambridge, and there is no doubt it is of the same species as ours. Lastly, in a supplementary paper (1854, Ann. and Mag. Nat. Hist., vol. xiii.), Dr. Wright has stated that, having examined the original specimen of Agassiz's, *P. granulosa*, from the great oolite of Ranville, he has convinced himself of their identity with the British species. Specimens also of *P. Gervillii*, Ag., from the original locality, the "Kellovien" rock of Chaffour, Department du Sarthe, communicated by M. Michelin and M. Lorière, "were so entirely like those from the Inferior Oolite of Gloucestershire, that he would have mistaken one for the other had he not previously marked them." The vertical range of this species, then, even if we do not admit its identity with *P. aspera* and *P. sublævis*, would appear to be considerable.

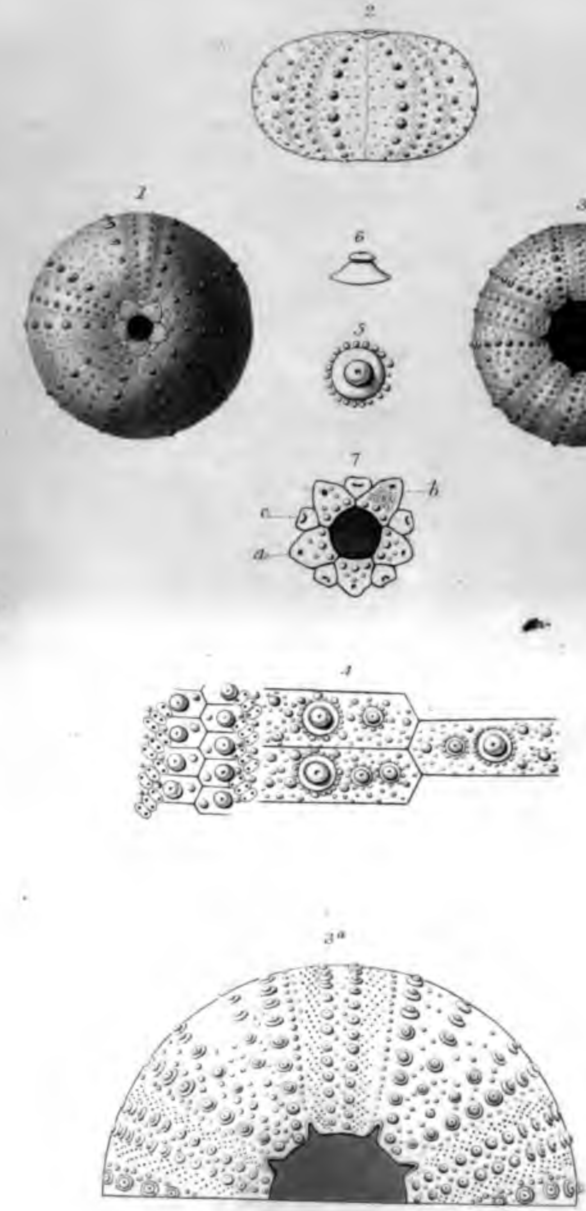
Localities.—INFERIOR OOLITE. In the upper beds of this formation at Shurdington Hill; CORNBRASH of Rushdon, Northamptonshire. [Dr. WRIGHT.]

Foreign Localities.—TERRAIN JURASS. des environs de Doubs, collected by M. Renard Compte (Agassiz); GREAT OOLITE of Ranville, Calvados; OXFORD CLAY, near Boulogne; KELLOVIEN of Chauffour, Sarthe. [Dr. WRIGHT.]

DESCRIPTION OF THE PLATE.

Fig. 1. Upper surface of a very round specimen of *Echinopsis rotata*, natural size, shewing the anal area and apical disk. (Coll. Geol. Surv.)

Fig. 2. Lateral view, the secondary tubercles are scarcely sufficiently evident in our figure, which is from an abraded specimen.



ECHINOPSIS (PEDINA) ROTATA — *Agassiz.*

Fig. 3. Under side, with the small ten-notched mouth.

Fig. 3*a*. A part of the same magnified.

Fig. 4. A few plates from the upper side of the test, magnified. (Dr. Wright's specimen.)

Fig. 5, 6. A primary tubercle, with its small smooth-edged boss, surrounded by miliary granules. 6, the same seen edgeways.

Fig. 7. The apical disk surrounding the anal space. *a*, perforated genital plate. *b*, that one which bears the madreporiform tubercle. *c*, ocular plate.

J. W. SALTER.

March 1856.

Notes on other British Species.

Prof. E. Forbes has left in MS. the following account of a large species of this genus in William Smith's collection, preserved in the British Museum:—

1. *Ech. Smithii.* Forbes, sp. nov. [*Cidaris*, sp. 2. of William Smith's Strat. System, p. 109.]

E. biuncialis pentagona depressa, superne granulosa tuberculisque magnis bifariis late divaricatis instructa: subtùs tuberculis quadrifariis, magnis, omnibus etiam ambulacralibus primaria fere æquantibus: ore profunde inciso.

> "'Pentangular depressed, with projecting and rather distant small mamillæ; two contiguous rows in each areola, and four converging rows in each area, the two middle rows short, and only on the side or widest part of the area: rough, with small points encircling the mamillæ; rays obliquely triporous.
>
> "'The areolæ form the angles of the pentagon. The two larger rows of mamillæ in each area are parallel to the rays, and converge to the aperture, and the space between them on the side is occupied by two shorter converging rows.
>
> "'*Locality.*—Tucking Mill.'

"The above is the description given by William Smith of a fossil from the under Oolite, to the original of which, preserved in the British Museum, my attention has been kindly directed by Mr. Woodward. Tucking Mill is in Moreton Combe, S.E. of Bath, and the beds from which this urchin came probably belong to the Coral Rag.

"The specimen is a fine fragment, exhibiting two interambulacral and an ambulacral area. The disk is broken away, but the notches of one angle of the mouth are exposed; they are deep, and have reflected edges. The tubercles on the ambulacral area, which is very narrow, closely alternate, and are smaller* than those on the interambulacrals. The inferior interambulacral plates bear, towards the periphery (and below it), two tubercles each: the superior ones bear only one each, and that towards their outer margin. The tubercles are deeply perforated. The boss is elevated and smooth-edged, with a deeply channeled summit, and with a distinct flattened areola at its base. The intermediate spaces between the two rows of primaries above, and among the large tubercles on the under surface, are occupied by very small perforated secondary tubercles with areolæ, and with granules round them. The diameter of the test was nearly two inches, and the height about one inch. The pores are arranged in three ranks, and become close and crowded below."

E. F.

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* They are so, but on the under surface are unusually large, and to the eye appear equally conspicuous with the primaries. This appearance has therefore been adverted to in the diagnosis. On the upper half of the superior face they abruptly cease.—J. W. S.

2. There is another species in the Inferior Oolite of Crickley nearly of the size of the *E. Smithii*, but more convex above, and with the pores in much more oblique rows. (Dr. Wright's Collection.)

3. *E. Bakeri.* (*Pedina*, Wright, 1854, in Ann. Nat. Hist., vol. xiii, pl. 11. fig. 4. *Hemipedina Bakeri*, ib. (1855), vol. xvi. p. 97.) *an præcedentis* (*E. Smithii*) *junior?*

A small species, much resembling the *Ech. Smithii.* The round contour, and the ten nearly equal distant rows of primary tubercles, will well distinguish it at present. The pores being arranged nearly in single file on the upper portion might be only a character derived from difference of age.

Locality.—INFERIOR OOLITE. Crickley Hill and Leckhampton, Gloucestershire. [Dr. Wright.]

One species of this section has been described from the British Tertiaries. It is—

4. *E. Edwardsii*, Forbes, Monog. Ech. Brit. Tert., Palæont. Soc. (1852), pl. 3. f. 2. Morris's Catal., 2nd edit. p. 78.

A small neat species, not half an inch broad, with narrow ambulacra, which have prominent tubercles except quite at the top, and crowded pores, the arrangement of which is such that instead of falling into ranks of threes, descending obliquely from the ambulacra outwards, they form ranks oblique in the other direction, viz., *towards* the ambulacrum. It is an unusual arrangement, and may be useful as a specific character. From this position of the pores the avenues are broad, and deducting these, the interambulacral spaces are not above twice as broad as the others ("three times," Forbes), and the tubercles are larger, less closely placed (about eight from the apex to the periphery), and nearly of equal size all the way up, while the ambulacral ones fail suddenly, and become mere granules at the upper part. The figure in the Pal. Monograph. does not express this character perfectly. The surface is granulated, and there are secondary tubercles as well as granules on the interambulacra, which are only smooth down the suture.

Locality.—LONDON CLAY. Bracklesham Bay, Sussex. (Mus. Pract. Geol.)

J. W. S.

Notes on Echinopsis, by S. P. Woodward, Esq.

In the second edition of Morris's Catalogue, p. 78, four species of *Echinopsis* are enumerated, viz.:—

E. Edwardsii, Forbes.
E. pusilla, Rœmer.
E. rotata, Agassiz.
E. Smithii, Forbes.

Of these, *E. rotata* and *E. Smithii* fall into the sub-generic division *Pedina* of Agassiz. *E. pusilla* was erroneously referred to the group; it is probably identical with *Ech. radiatus* (Hœningh.), and is known in France by the name of *Temnopleurus pulchellus* (Sorignet, Oursins foss. de l'Eure, p. 31). It is the type of M. Haime's proposed new genus *Glyphocyphus* (D'Archiac and Haime's Foss. de l'Inde, I., p. 202. Desor, Syn., p. 102.)

E. Edwardsii agrees with *Pedina* in the character formerly supposed to be essential, viz., the arrangement of the pores *in threes;* but in his new synopsis, M. Desor places with *Echinopsis* the Tertiary species (*E. Gacheti*), in which, as in *E. Edwardsii*, the pores are tripled.

Since the publication of Morris's Catalogue, Dr. Wright has described no less than fifteen additional species from the English Oolites, in which the pores are more or less in single file. To these he has given the name *Hemipedina* (Ann. Nat. Hist., August, 1855), whilst M. Desor has proposed the name *Diademopsis* for the same group, in the second part of his Synopsis, p. 79. Some of the species appear, too, to have been described by him under other names:—

Lias Species.

5. *Hemipedina Bechei* (*Cidaris*), Brod.
Locality.—LIAS of Lyme Regis. (Mus. Geol. Society.)

6. *H. Bowerbankii*, Wr.
Locality.—Lyme Regis. (Coll. Mr. Bowerbank.)

7. *H. Jardinii*, Wr.
Locality.—Ilminster (Mr. Moore). Bredon (Mr. Strickland).

8. *H. Etheridgii* (*Pedina*), Wr.
Hypodiadema Etheridgii, Desor, Syn., p. 61.
Locality.—Ilminster (Mr. Moore).

Inferior Oolite.

Hemipedina Bakeri, Wright. This species is a true *Pedina*, having the pores in threes (see above); M. Desor has unfortunately placed it with *Hemicidaris stramonium*, in his very ambiguous genus "*Hemidiadema*," Syn. Ech., p. 57.
Locality.—Crickley, Dr. Wright.

9. *H. perforata* (*Goniopygus?*), Wr.
Same locality.

10. *H. tetragramma*, Wr.
Same locality.

11. *H. Waterhousei*, Wr.
Same locality.

12. *H. Bonei*, Wr.
Same locality.

Great Oolite and Cornbrash.

13. *H. Davidsoni*, Wr.
Locality.—Minchinhampton.

14. *H. Woodwardi*, Wr.
Locality.—Wilts (Dr. Wm. Smith), Dr. Wright. Marquise, near Boulogne. (Brit. Mus.)

Coral Rag.

15. *H. tuberculosa*, Wr. This appears to be the *Hemicidaris depressa* of Ag., Cat. 9.
Locality.—Lyneham (Wm. Buy). Brit. Mus.

16. *H. Marchamensis*, Wr.
Locality.—Marcham, Berks. (Coll. Hon. R. Marsham.)

Kimmeridge Clay.

17. *H. Morrisii*, Wr.
Locality.—Aylesbury. (Z. Hunt, Esq.)

18. *H. Cunningtoni*, Wr.
Same locality and collection

S. P. WOODWARD.

March 1856.

BRITISH FOSSILS.

DECADE V. PLATE IV.

ECHINUS PERLATUS.

[Genus ECHINUS. LINN. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Cidaridæ.) Body inflated; interambulacral areæ composed of numerous plates; ambulacral areæ about half the width of the others, and with tubercles of as large a size; pores in transverse, oblique, or arched ranks of three or four pairs; anus covered by numerous small plates, and surrounded by five genital plates, one of which (the left posterior, Müller) is considerably enlarged, and bears the madreporiform tubercle.]

DIAGNOSIS. *E. biuncialis, rotundus seu pentagonus, supra granulosus, subtus muricato-tuberculatus; ore pentagono angulis bifidis. Tubercula primaria conspicua, in utrâque areâ bina, in singula serie ambulacri circa* 38,—*interambulacri* 29—*secundariis supra minoribus paucis sæpe nullis, subtus maximis numerosis; granulis crebris conspicuis. Ambulacra vix latitudine dimidium interambulacrorum attingentia sæpe prominula. Pori in series triplices parallelas—in juniore plus minusve obliquas, collocati.*

SYNONYMS. KNORR, Rec. des Mon. (1768), pl. E. 2. fig. 1, 2. LESKE apud KLEIN (1778), p. 92. pl. 40. fig. 7. (*nisi icones illæ E. gyrato potius referendæ*). *Echinus perlatus*, DESMAREST (1825), Dict. Sc. Nat., t. 37. p. 100. FORBES (1854), in Morris's Catalogue, 2nd edit. WRIGHT (1851), Ann. and Mag. N. Hist., vol. viii. 2nd ser. 274.

VAR. α, *germinans, fig.* 1–4.—*Pentagonus conicus, in medio interambulacri depressus, sæpe lævigatus; basi subplano; angulis oris productis; tuberculis secundariis insuper paucis; poris parallelis.—E. germinans*, PHILLIPS (1835), Geol. Yorkshire, pl. 3. fig. 15. *E. diademata*, M'COY (1848), Ann. Nat. Hist., vol. ii. p. 410.

VAR. β. *perlatus.—Rotundus inflatus elevatus seu subdepressus, basi subconvexo; tuberculis secundariis numerosis magnis, granulis valde conspicuis; poris in series parallelas plerumque collatis.—E. perlatus.* AGASS., Ech. Suisses (1839), t. 22. fig. 13–15. *E. psammophorus*, ibid., fig. 1–3. *E. lineatus*, GOLDFUSS (1826), Petr. Germ., t. 40. fig. 11. *E. perlatus*, Agassiz and Desor (1846), Cat. Raisonné, Ann. Sc. Nat. 3rd series, vol. vi. p. 365. *E. multigranularis*, Cotteau (1850), Etudes Ech. Foss. de l'Yonne, p. 63. tab. 7. fig. 6–8.

Var. γ, *serialis, fig.* 5.—*Depressus granulosus, tuberculis primariis ambulacralibus minoribus, secundariis insuper rarissimis, ad latera interambulacrorum in serie unica dispositis; fasciis pororum latis; poris parallelis: basi subconvexa; ore angulis obtusiusculis.*—*E. serialis*, Agassiz, Ech. Foss. Suisses, l. c. fig. 10–12. Wright, Ann. and Mag. Nat. Hist., l. c. pl. 13. fig. 2. Ag. and Desor, l. c. p. 366.

Var. δ, *Forbesii, fig.* 6.—*Rotundus seu pentagonus granulosus; tuberculis primariis conspicuis, ambulacralibus minoribus irregularibus: fasciis pororum angustis, seriebus usque ad orem valde obliquis.*

At first sight it would appear very unlikely that the forms here figured should be all of one species, or that either of them could be identified with the much rougher and more globose *Echinus*, which Agassiz calls "sans contredit l'un des plus beaux oursins connus."

The comparison of the several English specimens, however, with one another, and with the foreign types, convinced both Prof. Forbes and Dr. Wright that they were identical, and as such they have been quoted in the second edition of Morris's Catalogue.

Agassiz has placed this fossil species and several others allied to it with his first section of the genus, in which the pores are arranged in triple oblique (not arched) rows, and in which the buccal membrane, instead of being covered all over with calcareous plates, has only five escutcheon-like plates disposed around the mouth. The margin of the latter is deeply notched, and in these notches lie those curious branched processes which Prof. Forbes counted analogous to the oral tentacula of the *Holothuriæ* (Prof. Müller terms them 'tree-like gills').

Description.—The variety *germinans*, forming the principal subject of our plate, requires more particular notice. It is conical and elevated above, flattened and even excavated below. Diameter of the largest English specimen, 3 inches, its height 2 inches. The outline, looking from above, is subpentagonal rather than rounded; the ambulacral areæ being rather more convex than the others, which are depressed along their median line.

The breadth of the interambulacral spaces is 2½ times that of the ambulacra at the widest part; the number of plates in a row is twenty-nine, of which eight are basal, and, in English specimens, bear three or four very large primary tubercles, with a few secondaries at the outer angles. At the turn of the margin these all disappear, and the upper plates only bear each a single primary, of a smaller size, in the middle, flanked by a row of secondary tubercles on the inner side, and one or two rows on the outer margin towards the avenues. These secondary tubercles, except the outer rows, do not, in our largest specimens, reach above half way up the test, and these rows, on the base, are nearly equal to the primaries in size.

The two principal rows of primary tubercles lie nearer to the ambulacral rows than to each other; they are the only ones which extend all the way from the apex to the base. Their tubercles are rather closely placed, and nearly of equal size throughout, while those of the ambulacral rows are smaller towards the apex. They are placed upon rather sunk mammillæ, which are smooth-edged above, but often present indications of the radiated muscular markings on their outer margin. Each has surrounding it a circle of granules of considerable size, and the entire surface of the plates is covered pretty equally with similar granules, except above along the median line of the interambulacra, where, for a short space, the surface is bare.[*]

The ambulacra are pointed above, but parallel sided below; the tubercles in two rows, about thirty-eight in a row, of which ten are basal ones; and between these, on the lower surface only, and in large specimens, are four or five others of equal size, in a zig-zag row. Granules surround the tubercles, and fill up the surface as in the interambulacral spaces; but here and there along the sutural line the surface is smooth. The poriferous avenues are slightly sunk beneath the general surface, especially near the mouth. Their breadth above is about half that of the rest of the ambulacral space, —a little less at the turn of the margin, and then again it widens out considerably. The pores are ranked in threes, in parallel and but slightly oblique rows in this variety (with a row of about three granules between each set), except near the apex, where the ranks are much more oblique. Each pair of pores is surrounded by an oval ring, and set obliquely, but not so much so as in our figure. There is no tubercle or bar between the pores. The mouth is pentagonal, with two deeply incised notches at each angle beneath the interambulacral spaces. Between these the oral margin is rounded, but beneath the ambulacra it is nearly a straight line. The apical disk is well preserved; we have figured it from both varieties; the round variety (fig. 6), in which the ovarian plates are somewhat more obtuse, and the var. *germinans*. In the latter the five genital plates are heptagonal, with a broad indented base, and pierced near their outer margin by the ovarian pore; the five oculars between them are small pentagons pierced also near their base or outer edge. A circle drawn round the plates of the disk would touch or nearly touch the outer edges of all, excepting the madreporiform plate, which is generally swelled as well as enlarged, at least in the pentagonal variety.

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[*] This character exists to a much greater extent in the closely allied *E. gyratus*, Ag.

Variations.—If all the specimens on our plate be referable to the same species, the species is a very variable one indeed. It varies in height,—from a rotund to a pentagonal and even sublobed form,—and very greatly in the degree of development of its tubercles and of the granules of the test. These last are, in the typical foreign examples, of considerable prominence, so much so as partly to obscure the primary rows; while in our British examples, though we have a few that show as many secondary tubercles, yet these last are always smaller, and in the extreme variety (*Forbesii*, fig. 6, if variety it be), the surface is pretty uniformly covered with small granules, amongst which the rows of large tubercles are conspicuous, both on the interambulacral and ambulacral areas. This kind of arrangement gives its character also to the next variety, called *E. serialis* by Agassiz; the large tubercles are not in reality more prominent than in other varieties, but they appear so from the want of secondary tubercles among them.

VAR. *Forbesii*, fig. 6.—Besides the circular inflated form, in which it resembles *E. perlatus*, and differs from the variety above described, a view of the underside of this variety shows a distinction in the mouth, which Prof. Forbes has noted in his MSS.: "The mouth notches are acute," he says, "in *E. perlatus* (the pentagonal form), obtuse in *E. serialis** (our figured specimen, fig. 6). Moreover, in *E. perlatus* the pairs of pores are much less oblique, so that the series become parallel on the upper surface of the test as well as below; whereas in *serialis* the pores are only subparallel, beginning from the fourth row of pores from the mouth." This is a character which occurs in the young of other varieties, but *only* near the apex. Probably older specimens of the var. *Forbesii* would have the pores more parallel. The avenues are very little sunk either on the upper or lower face of the test, and the interambulacral spaces not at all indented along their middle. The arrangement of the tubercles is much the same, as in var. *germinans*, but in the outer interambulacral rows appear not to extend so far up, and in the ambulacra there are fewer large tubercles developed.

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* Prof E. Forbes regarded this variety as the *E. serialis* of Agassiz; but for the reasons assigned in the next page it is here described as var. *Forbesii.*

VAR. *serialis.*—We prefer to apply this name, as Dr. Wright has done, to the depressed variety with pores in close ranks of threes, rather than to our figure 6, which has them oblique. Agassiz's small figure shows close set tubercles in the ambulacral areas, and those two rows are made greatly nearer to each other than to the interambulacral rows, while the pores are described as "no less in ranks of threes than those of *E. perlatus.*" These two characters, the approximate ambulacral rows, and the close ranked pores, agree with specimens from Verona in the British Museum, and with the larger specimen described by Dr. Wright, as above quoted. This specimen is very evenly covered with granules, and the ambulacral tubercles, more numerous than in the typical variety or in var. *germinans*, are remarkably irregular in size (see our fig. 5). Some specimens of this variety in the Survey collections are considerably more pentagonal than our figure, and have the ambulacral rows wider apart, but have the surface and the pores similar.

VAR. *perlatus.*—In the typical variety the form is much inflated, and also moderately elevated. The avenues are broad and not sunk, though the ambulacra project a little. The tubercles are prominent in both areas, and surrounded by conspicuous large granules, intermixed with secondary tubercles on both sides of the primaries over a great part of the surface. These become equal in size to the primaries on the under surface, which is therefore crowded with large tubercles. The median line of the interambulacra is bare of granules (but not depressed), and they are occasionally absent down the middle of the convex ambulacra. In one fine specimen in the British Museum, like that figured by Goldfuss as *E. lineatus*, the rows of pores are in close threes all the way up; in another, more elevated, this arrangement alters at the upper third, and the rows become quite as oblique as in our figures 5, 6. The base of *E. perlatus* is convex, more so in depressed specimens, and the angles of the mouth are produced. Not yet found in Britain.

There is a considerable interval between this variety and the next, but there can be little doubt of their identity as species.

VAR. *germinans.*—The differences observable among specimens of this variety are chiefly those due to age (the young being more depressed), and having the pores *more oblique ;* some of those from the Inferior Oolite, however, are less pentagonal, and with the median line of the interambulacra less depressed, and not so bare of tubercles at the upper part as those from Yorkshire, while the granules are also less conspicuous. Some specimens have the ambulacra more prominent than others, and the avenues a little sunk. The mouth varies in shape and in the depth of the notches. The anus is rounder when young, and more angular in old specimens.

History.—Knorr's old figures of this fossil are tolerably characteristic, and it is generally believed he intended this species. He refers also to Klein; and in Leske's "Additamenta" to that author (1778), Knorr's figure is wretchedly copied, and made to look like a many-lobed species.* The specimens were found with acicular spines in connexion with them at Pfeffingen, in Basle, from which locality Desmoulins quotes the species as one he had not seen.

Agassiz and Desor, in the Catalogue Raisonné, refer to Desmarest for the name. His short description, in the Dict. des Sc. Nat., states that his specimen had no locality, but that it was probably from beds older than the chalk, and that others very like it were found in the Jura. Goldfuss, in 1826, gave an excellent figure of it, under the name of *E. lineatus*, showing clearly the granules in circles round the tubercles, and also the parallel rows of pores. He has well expressed the general rough appearance of the species, even better than in Agassiz's more complete figure in the Ech. Suisses. In that work a smaller variety was figured, and called by Agassiz *E. psammophorus*, which he afterwards united with the larger species; and also the *E. serialis*, which he does not appear to have regarded as a mere variety in his Catalogue Raisonné, 1846. In the meantime Phillips had enumerated, without a description, the variety *germinans* in the Geology of Yorkshire,† which Prof. M'Coy republished, in 1848, as *E. diademata*, from the original locality. M. Cotteau's description and figures of his *E. multigranularis* are good representations of the typical *E. perlatus;* and lastly, Dr. Wright has described a large conical variety and a depressed one (the latter as *E. serialis*) from his own neighbourhood in Gloucestershire. His description rightly includes a synonymy of the several varieties, and this has been confirmed by the late Prof. E. Forbes, in the second edition of Morris's Catalogue, 1854. The var. *serialis* and that we here term *Forbesii* were not included in that synonymy, but, in accordance with the Professor's own views, as shown in the arrangement of the plate, and after carefully examining the specimens in the Museum of Practical Geology, they are here united; the var. *Forbesii* may, however, eventually be regarded as a distinct species.

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* Unless indeed there is a general mistake in referring to that figure, which may very probably be intended for the *E. gyratus*. *See* note on that species.

† "His figure, a slight outline, is characteristic enough, but the avenues of pores are so indicated that the pores might be supposed to be in single file" (Forbes).

Affinities.—If *E. bigranularis* of Agassiz (and its variety *E. intermedius*) be not the same species with ours, it must be closely allied. The description of M. Cotteau would make it appear to be a depressed variety much like *serialis;* it has but two rows of primaries in each area. It occurs with the *perlatus* in the Great Oolite of Grimaux, Yonne. According to M. Cotteau, *E. intermedius* of Agassiz is only a variety of *bigranularis*, a view in which Dr. Wright agrees. The *E. gyratus*, Agassiz, well figured by him in his Ech. Suisses, differs at first sight materially from the present species in the great number and small size of its tubercles, two and even three rows being arranged outside the principal ones, and one or two down the ambulacra. The latter are prominent, and the avenues sunk, and the median line of the intervening areas is bare of tubercles all the way down, and so much impressed that the species looks lobed. It is nevertheless a most closely related species.

Localities and Geological Range.—UPPER? and LOWER OOLITES. CORAL RAG, Malton, Scarborough (Prof. Phillips' and Brit. Museum Collection*). Var. *germinans*, GREAT OOLITE, Whitwell, Yorkshire (Forbes). INFERIOR OOLITE, Crickley Hill, Gloucestershire (Survey Collection); Leckhampton and Cleeve Hills (Survey Collection); Stroud; Nailsworth; Minchinhampton; Dundry (Dr. Wright).

Foreign Localities.—CORAL RAG (Etage Corallien), "Terrain a Chailles," Val de Moutiers, Ile de Ré; Salins; Besançon (Agass. and Desor). GREAT OOLITE (Terr. Bathonien), Grimaux, Departement de l'Yonne (Cotteau). Var. *serialis*, Fringeli, Canton de Soleure (Agassiz).

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* Dr. Wright has good reason for believing that this is an error of locality, and that *E. perlatus* is not found in Britain above the Great Oolite.

The Oolitic species of *Echinus* are so fully described, and also figured, by Dr. Wright, in the paper above referred to, that it is unnecessary to do more than enumerate them; the first mentioned, however, has not been yet figured in any British work.

1. *E. gyratus*, Agass., Ech. Suisses, t. 23. f. 43-46., 1839; Catal. Raisonné, 1846, l. c., p. 366.; Forbes, in Morris's Catalogue, 2nd edit. (1854), 79. *E. petallatus*, M'Coy, Ann. Nat. Hist., 1848, vol. ii. p. 409.

E. biuncialis subconicus, pentagonus, lobatus, tuberculis numerosis—in areâ ambulacrali ad basin quadrifariis, in alterâ seriebus sex vel octo—omnibus subequalibus; spatio mediano interambulacri lato lavigato; poris subparallelis.

E. petallatus of M'Coy is undoubtedly this species. It is a very elegant one. In all probability Knorr's old figure belongs to it. Leske's certainly represents it far better than it does the *E. perlatus.*

Locality.—Coral Rag. Wiltshire (Brit. Mus.); Besançon (Agass.); Havre (Brit. Mus.).

2. *E. granularis*, Wright, Ann. and M. Nat. Hist. (1851), vol. viii. 2nd ser. p. 277.

A small species, distinguished from *E. perlatus* by its depressed and pentagonal form, and its granular appearance, the latter arising from the great number of tubercles, six or eight rows, in the interambulacral area.

Locality.—Inf. Oolite. Leckhampton Hill (Dr. Wright).

Of the Section *Arbacia.* Pores in single file.

E. (*Arbacia*) *Forbesii*, Wright, l. c. pl. xiii. f. 4.

A small hemispheric species, with narrow convex ambulacra and interambulacral areas, depressed and almost lobed along the median line, covered by small equal tubercles.

Locality.—Inf. Oolite. Dundry (Dr. Wright).

E. (*Arb.*) *nodulosa*, Wright, l. c. pl. xiii. f. 3.

Ech. nodulosus, Goldfuss, Pet. Germ. t. xl. f. 16.

A subpentagonal small species, covered with thick set tubercles, of larger size than in the last. The ambulacra are prominent.

Locality.—Great Oolite. Sevenhampton Common, Gloucestershire. (Dr. Wright's Collection, Münster's specimen was found at Baireuth.)

Explanation of Plate.

Fig. 1. *Echinus perlatus*, var. *germinans*; upper side, with anal disk complete (Malton). Cabinet of Prof. Phillips.

Fig. 2. The same; lateral view.

Fig. 3. Flattened under side, showing the pentagonal deeply-notched mouth.

Fig. 4. Outline of the large specimens of var. *germinans*, from the Inferior Oolite of Crickley Hill, Cheltenham.

Fig. 4a. Ambulacral and interambulacral plates of this variety, shewing the distinct circles of granules round the bosses, the pores in parallel ranks of threes.

Fig. 4b. Under side of do., showing the large secondary tubercles, and the pores in closer and more transverse rows, with granules among them.

Fig. 4c. Anal plates of a large specimen.

Fig. 5. Ambulacral and interambulacral plates of var. *serialis*. The ambulacral tubercles very irregular; magnified. Crickley Hill.

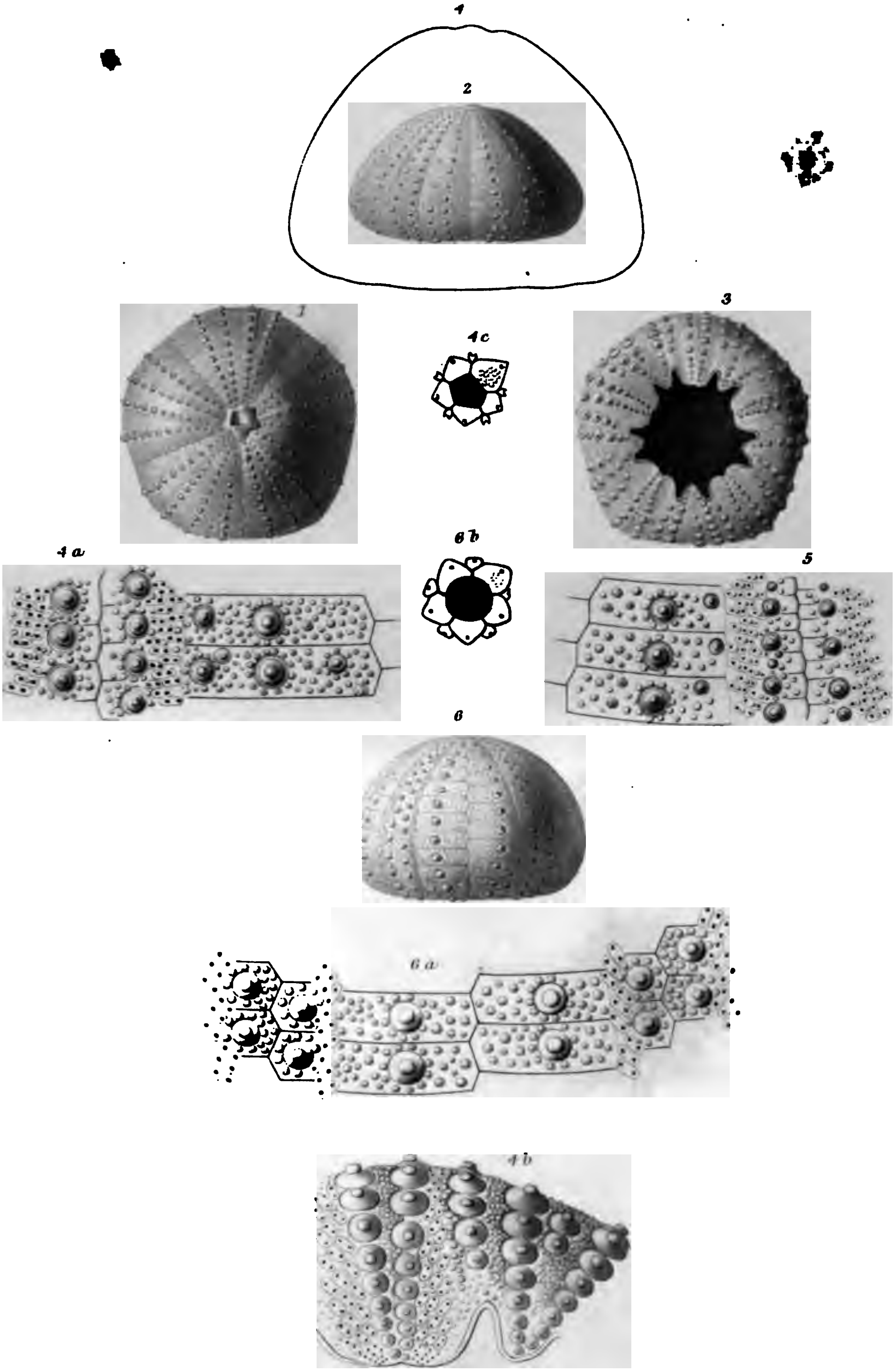
Fig. 6. Var. *Forbesii*, from Crickley Hill. This is evenly covered with granules, the primary tubercles therefore are more conspicuous.

Fig. 6a. Plates and pores of do. magnified, the triple series of pores very obliquely placed.

Fig. 6b. Anal plates of this variety. The madreporiform plate is not greatly enlarged.

March 1856. J. W. Salter.

ECHINU
(Oolitic)



ECHINUS PERLATUS_ *Desmarest*.

BRITISH FOSSILS.

DECADE V. PLATE V.

CIDARIS CARTERI.

[Genus CIDARIS. KLEIN, 1734. (Sub-kingdom Radiata. Order Echinodermata. Family Cidaridæ.) Body sphæroidal; ambulacra narrow, undulating, with two or more rows of miliary granules only; pores in single file; interambulacral segments very broad, with two rows of primary tubercles, few in number, the uppermost often rudimental; interspaces of the areolæ densely granulated; apical disk large, of 5 large genital and 5 ocular plates, round a pentagonal anal area minutely plated; oral opening round, simple, its disk composed of small imbricating plates. Primary spines few and large, all the rest small and flattened.]

DIAGNOSIS. *C. parva, subconica, ambulacris bigranulatis longitudinaliter sulcatis; tuberculis interambulacrorum conspicuis remotis—areolis omnibus parvis, superioribus elongatis, obsoletis.*

REFERENCES. *C. Carteri*, FORBES (1854), in Morris's Catal., 2nd edit. p. 74. DESOR (1854), Synopsis des Ech. Foss. p. 12.

Description.—*Cidaris Carteri* is the smallest species of the genus found in the English chalk; the specimen represented, though apparently adult, only measures 10 lines in diameter and 8 in height. It is like a minature of the well-known *C. sceptrifera*, from which it differs chiefly in the more conical form, and in the less development of the areolæ in the uppermost plates. The ambulacra have only two distinct and two indistinct rows of granules, whereas the adult *C. sceptrifera* has four distinct and two indistinct rows. The primary tubercles are perforated, but not crenulated, and the areolæ are deeply sunk and surrounded by a rather conspicuous circle of mamillated granules. The apical plates are less roughly and densely granulated than in *C. sceptrifera*, and the oculars are relatively much smaller.

Locality and Geological Position.—The only specimen at present known is in the collection of James Carter, Esq., of Cambridge, who obtained it from the LOWER CHALK of that neighbourhood. In

Morris's Catalogue it is erroneously stated to belong to the "Upper" Chalk, and in Desor's Synopsis to the "Gres vert sup."

Explanation of the Plate.

Fig. 1. Side view, natural size.

Fig. 2. Upper view, or dorsal surface.

Fig. 3. One of the interambulacral plates, and part of an ambulacrum, from the circumference.

Fig. 4. Apical disk, magnified.

Fig. 5, 6. Miliary spines, magnified.

Note on some other Species of Cidaris found in British Strata.

In Professor Morris's Catalogue three other species of *Cidaris* are enumerated, and referred to the unpublished MSS. of Professor Forbes.

Cidaris confluens Inf. O., Cheltenham.
C. dissimilis, L. Ch., Kent, Sussex.
C. Gaultina, Glt., Folkstone.

The characters may be given as follows :—

1. *Cidaris dissimilis*, Forbes, MS. Morris's Cat., 2nd. edit. p. 74. *C. sceptrifera*, Forbes in Dixon, pl. 25. f. 3.

Body small, 11 lines in diameter, 6½ lines high, resembling *C. sceptrifera* in general character ; ambulacra narrow, flexuous, with six ranges of small granules ; interambulacral plates 4–5 ; areolæ circular, wide apart, surrounded by distinct secondary tubercles ; principal tubercles prominent, slightly crenulated,—the lowest minute, the uppermost rudimentary and without areolæ ; miliary granules large and prominent. Spines of two sorts ; the largest above, 24 lines in length, slightly swelling above the collar (2½ lines diameter), and then tapering to a fine point ; collar short, striated finely ; shaft granulated in lines ; spines of lower surface very slender, 3–6 sided, serrated at the angles ; spines of areolar circles 2 lines in length, compressed and striated.

Locality.—Grey Chalk, Dover. Collected by Messrs. Clarke, Dixon, and Taylor, (now in Brit. Mus. and Mus. Pract. Geology).

2. *Cidaris confluens*, Forbes, MS. Morris's Cat., 2nd edit. p. 74.

The specimen consists of four consecutive plates of nearly equal size, from one of the interambulacral rows. The set measures 1 inch in length and ½ inch wide. The areolæ are 4 lines wide, and broadly confluent one with another ; the bosses prominent and crenulated ; the lateral borders of the plates are narrow and uniformly granulated. There are numerous fragments of spines in the same piece of rock ; they appear to have been very long, slender, cylindrical, striated lengthwise, and armed with a few large scattered prickles.

Locality.—Inferior Oolite. Frome (not Cheltenham).

3. *Cidaris Gaultina*, Forbes, MS. Morris's Cat., 2nd edit. p. 74.

Detached plates of this species resemble those of *C. vesiculosa* (*subvesiculosa*, D'Orb.) from the Chalk. A plate from the upper part of the test has the areola surrounded by a circle of secondary tubercles, but not depressed. The spines are like those of *C. vesiculosa*, slender, elongated, and fluted, the ridges being more finely serrated ; the collar of the spine is shorter than in *C. vesiculosa*. A broken spine accompanying the plates has the end expanded and cup-like; but in two other perfect examples the extremities are simply contracted and truncated.

Locality.—Gault, Folkstone. (Mus. Practical Geology. Presented by Edward Clark, Esq.)

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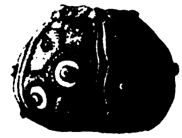

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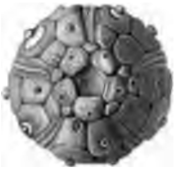

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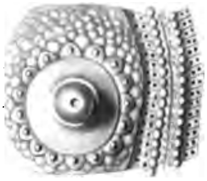

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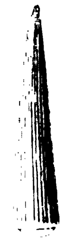

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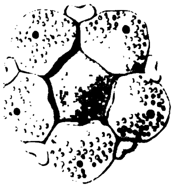

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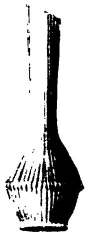


CIDARIS CARTERI *Forbes*.

4. *Cidaris velifera*, Bronn. (Name only) Jahrb. 1835. p. 154. Desor, Syn. Ech. p. 34. t. 6. f. 12. *C. Heberti*, ib. p. 12. Syn. *C. globiceps*, Quenst., Petref. p. 577. t. 49. f. 17.

Of this small species there are three specimens in Mr. Cunnington's cabinet, one of them with six spines attached. The body measures 6 lines in diameter by 3 in height, and is like *C. clavigera* of the Upper Chalk; the spines are globular, measuring only 2 lines, with a very short stalk.

Locality.—UPPER GREEN SAND of Warminster.

5. *Cidaris sceptrifera*, König. (Dixon's Geol. Sussex, pl. 25. f. 5, 6. best figures.) The spine figured by M. Desor, with the name "*C. filamentosa*, Ag." Synops. Ech. Foss. t. 5. f. 22., perfectly agrees with the typical specimens of *C. sceptrifera*; that figured as *C. sceptrifera* is more like a large broken spine of *C. dissimilis.*

6. *Cidaris sulcata*, Dixon, MS. Morris's Cat. 2nd edit. p. 75. *Cidaris sceptrifera*, var. *spinis truncatis*, Forbes, in Dixon's Geol. Sussex, p. 338. t. 25. f. 32, 33. *Cidaris vesiculosa*, Münst. (part.) Copied by Desor, Syn. Ech., pl. 5., f. 24, 25.

7. *Cidaris pleracantha*, Ag.? Dixon, Geol. Sussex, pl. 24. f. 23, 24. What has become of the figured spine is unknown; two rather smaller specimens are in the Dixonian Collection, now in the British Museum.

8. *Cidaris florigemma*, Phil. (1829), Geol. Yorks. 1. t. 3. f. 12. Park. Org. Rem. 3. t. 4. f. 15. *Cidaris Blumenbachii*, Desor, Synopsis, p. 5 (not Münster).

This very abundant urchin has been frequently called "*C. Blumenbachii*;" Münster having inadvertently figured its spines (and those of two others) as possibly belonging to the *test*, upon which he founded his species. The real *C. Blumenbachii* has not been found in England, unless the larger species obtained at Calne is to be considered a variety of it; there are fine specimens in the collection of Wm. Smith (Brit. Mus.), and Dr. Wright. M. Desor makes *C. crucifera*, Ag. the "young" of *C. florigemma*; but if not a distinct species it is certainly related to *C. coronata* and not to *C. florigemma.*

Locality.—CORAL RAG, Calne. Wilts.

S. P. WOODWARD.

March 1856.

BRITISH FOSSILS.

DECADE V. PLATE VI. Fig. A.

PYRINA DESMOULINSII, VAR. PRATTII.

[Genus PYRINA. DESMOULINS, 1835. (Sub-kingdom Radiata. Order Echinodermata. Family Cassidulidæ.) Body oval, tumid, flattened above and below; ambulacra simple, continuous, radient; mouth central inferior, elliptical; anus posterior, supramarginal; tubercles perforate; genital pores four.]

DIAGNOSIS. ***P. testâ tumidâ, ambitu elliptico postice leviter emarginato; vertice depresso; basi subconcavâ; ano in medio faciei posticæ excavato.***

REFERENCES. *Pyrina Desmoulinsii*; D'ARCHIAC (1847), Mem. Soc. Geol. France, 2nd ser. t. ii. pl. 2. p. 297., pl. 13. fig. 4.; D'Orb. Prodr. 2., p. 78.; Agass. Cat., p. 92. *Pyrina Prattii*, FORBES, Morris's Catal., 2nd edit. (1854), p. 88.

Several members of the family *Cassidulidæ* have been already presented in the Decades, more particularly of that division of it which has simple, instead of petaloid ambulacra—*Disaster*, *Galerites*, *Hyboclypus*. The species having this character (the *Echinoneides* of Agassiz) are abundant in the cretaceous rocks; two out of three sections of the genus *Galerites* are quite characteristic of the Chalk and Green Sand.

Pyrina, which differs from *Galerites* chiefly in its oblong instead of circular outline, is a genus of rather small, and generally very convex urchins. It is difficult to distinguish from it those abnormal specimens of *Galerites* upon which M. Desor founded the spurious genus *Globator*. Such specimens occur in the Upper Chalk of Kent, and Upper Green Sand of Warminster, and differ from *Pyrina* solely in their more circular forms.

Description.—The original example of *Pyrina Desmoulinsii*, figured and described by M. le Vicomte d'Archiac, in his "Rapport sur les Fossiles du Tourtia," measures 22 mill. in length, 16 mill. transversely, and 11½ in height. The specimen now figured measures 24 mill. long, 19 wide, 12 high, and is therefore wider, and rather more depressed in relation to its length, than the typical example.

These differences are equally manifest in other specimens,—one British and three Belgian,—in the cabinets of Dr. Wright and the British Museum. In all the foreign specimens, when viewed from above, the outline is notched posteriorly by the vent; in the English specimens this is less distinctly the case, the anal opening being rather higher up, though not so high as in the Neocomian *P. pygæa*.

These differences are so slight, and the materials so scanty, that it will be better to treat them as indicating varieties only of one species.

Locality and Geological Position.—Mr. Pratt's specimen, and another in the cabinet of Dr. Wright, were obtained from the CHALK with quartz grains at Chard, Somersetshire.

The foreign examples are from the UPPER GREEN SAND (Tourtia) of Tournay, Belgium.

PLATE VI. Fig. B.

PYRINA OVULUM.

DIAGNOSIS. "*P. ovata, inflata, superne depressa; ambitu elliptico, basi plana, margine valde tumido; ore elongato obsolete decagono; facie posticâ late sulcatâ; ano elliptico, margini superiori proximo; tuberculis numerosis.*" —(DESOR).

SYNONYMS. ***Nucleolites ovulum***, **LAMARCK, Anim. sans Vert., vol. iii. 87. GOLDFUSS, Petr., 1. p. 138. t. xliii. f. 2. DESMOULINS, Ech., p. 356. *Pyrina ov.*, AGASSIZ (1847), Catal. Syst. Ectyp., p. 7. DESOR, Monogr. des Galei, p. 26. pl. 5. fig. 35–37.; Morris's Catal., 2nd edit. p. 88.**

Locality and Geological Position.—LOWER CHALK, Dorsetshire, (*sec.* Morris's Catalogue.)

Foreign Locality.—CHALK of St. Christophe and Tours, Department Indre and Loire.

EXPLANATION OF PLATE VI.

A. *Pyrina Desmoulinsii*, var. *Prattii*.

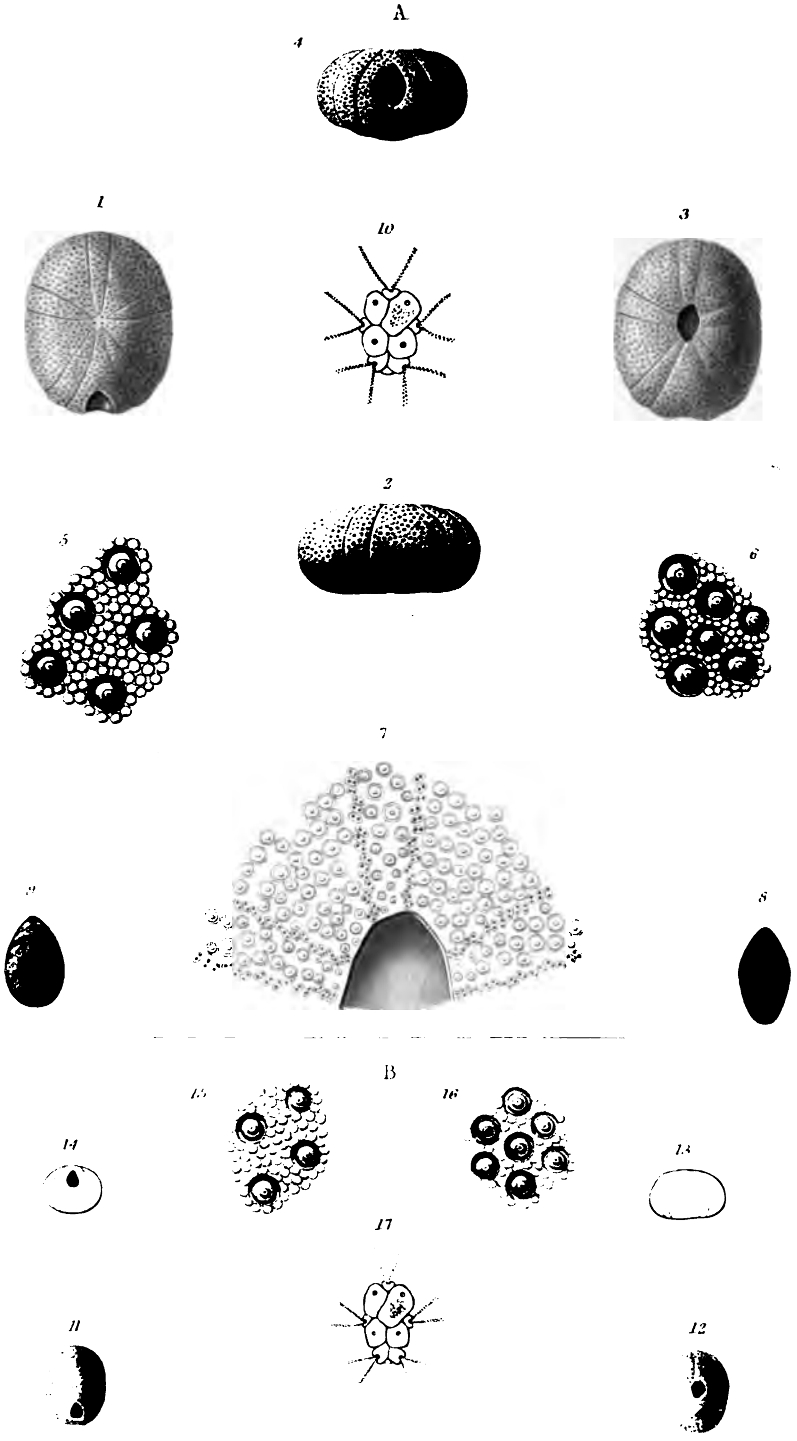
Fig. 1. Upper view of Mr. Pratt's specimen.
Fig. 2. Side view.
Fig. 3. Under view.
Fig. 4. Posterior end.
Fig. 5. Tubercles of the upper surface, magnified.
Fig. 6. Do. and granules of the lower face.

DECADE 5 Pl

ological Survey of the United Kingdom.

PYRIN

(Cretaceo



A PYRINA DESMOULINSII. *D'Archiac*, VAR. PRATTII _ *Forbes*.

B OVULUM *Lamarck*.

Fig. 7. Portion of the under surface magnified, showing the triplication of the pores near the mouth.
Fig. 8. Form of the mouth, magnified.
Fig. 9. Form of the vent.
Fig. 10. Plates of the apical disk, magnified.

B. *Pyrina ovulum*, Ag.

Fig. 11. Upper view.
Fig. 12. Under view.
Fig. 13. Side view.
Fig. 14. Posterior end.
Fig. 15. Tubercles and granules from the upper side, magnified.
Fig. 16. Do. do. from the base.
Fig. 17. Apical disk, magnified.

S. P. Woodward.

March 1856.

BRITISH FOSSILS.

DECADE V. PLATE VII.

PYGASTER SEMISULCATUS.

[Genus PYGASTER. AGASSIZ, 1834. (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Cassidulidæ.) Orbicular, depressed or subconic; ambulacra simple throughout; tubercles perforate (and crenulate ?), disposed in very regular series in both areas; anus very large, superior, generally placed near to the plates of the disk; mouth decagonal, no tubercles round it.]

DIAGNOSIS. *P. depressus, subpentagonus, margini postico subacuto, nec truncato; tuberculis conspicuis—primariis ambulacrorum supra binis, ad marginem in series* 4–5—*interambulacrorum* 18–22—*collocatis; basi in medio valde concavâ; ano majori lateribus tumidis.*

SYNONYMS. *Clypeus semisulcatus,* PHILLIPS (1829), Geol. Yorksh. vol. i. p. 104. t. 3. fig. 17. (fig. two-thirds nat. size). BUCKMAN, in Murchison's Geology of Chelt., 2nd edit. p. 95. (1845). *Nucleolites semisulc.* DESMOULINS (1837), Tabl. Syn., p. 362. *Pygaster semis.*, AGASSIZ, Prodr. Ech., p. 185. LAMARCK, Hist. Nat., 2nd edit. (1840), vol. iii. p. 353. WRIGHT, Ann. and Mag. Nat. Hist. (1852), vol. ix. p. 89. *Pygaster umbrella,* AGASSIZ, Ech. Suiss. (1839), tab. 13. fig. 1–3. DESOR (1842), Monogr. des Galerites, 3., p. 77. t. 12. fig. 4–6. FORBES, in Morris's Catalogue, 2nd edit. 88. (not *Galerites umbrella,* LAMARCK).

Description.—This fine Oolitic fossil is 3 inches across in either direction, and 1½ inch in height. The general form is subhemispheric, and the outline orbicular or very slightly pentagonal. The base is flat and deeply concave at the mouth.

The upper surface is most generally evenly convex, more rarely the sides are flattened and the shape low-pyramidal. The vertex from which the five ambulacra radiate at nearly equal distances, is rather behind the centre, and as the large oblong anal opening * is close to the plates of the disk, which are (always ?) lost, a broad keyhole-shaped cavity is left, which occupies the central and post-central portions.

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* In the young state this opening is far less conspicuous.

The ambulacra are equidistant and of equal width, scarcely one-fourth as wide as the spaces between them. The three anterior ones are nearly direct, while the two posterior ones are a little bent out near their origin, to conform to the tumid edge of the large opening; in the ordinary varieties they are not at all elevated above the intervening spaces. They are composed of very numerous (about 150) pairs of plates, judging from the number of primary tubercles—one to about three plates—and from the pairs of pores.

The primary tubercles in the ambulacral area are in four* rows on the under surface and about halfway up the superior face, but only the outer rows continue to the vertex. These rows are placed along the margin close to the pores, and there are about fifty-six tubercles in each of them, of which thirty-six belong to the upper, and twenty-two to the under surface. They are small, perforate, and set upon but little elevated mamillæ, which are sometimes irregular or even slightly crenulate above, but often appear quite smooth under the lens.

The surface of the ambulacral and interambulacral spaces are occupied by small granules not very closely placed, and mixed with a few secondary tubercles, the areolæ of which are distinctly sunk. A single row of these granules separates each primary tubercle from its neighbour, and they form rather a loose circle round each areola.

The avenues are not sunk in any of the typical specimens, and the pores are ranked in single file, as usual in the genus. They are rather large, and each pair (corresponding to one of the three plates opposite each primary tubercle) consists of an inner *roundish* and an outer *oval* pore, the two being placed in somewhat opposite directions, and separated by a strong elevated tubercle.

The interambulacra have numerous rows of equal-sized tubercles similar to those of the ambulacra, with an areola distinctly depressed at the margin; they are larger, at least in the principal rows, than those of the ambulacra, and more distant, there not being above nineteen or twenty in a complete row on the upper surface, and fourteen or fifteen below. They are arranged in the following manner: two complete rows down the centre of the interambulacral plates extend from the vertex to the mouth, and on the inner side of these—first one, then two (see 4*a*), and near the margin even four, rows appear placed in regular transverse rows on the plates. Outside the principal rows an equal or greater number of similar tubercles appear, but in loose order and not placed in regular line with the rest. Altogether about twenty rows (sometimes more) may be counted at or about the margin of an interambulacrum. On the under surface (fig. 3.), the transverse rows are very distinct, and the difference between the central and the exterior portions is particularly manifest. As the plates become square and less transverse near the mouth, the rows become more distant and irregular, till there are again (in the angles of the notches) only the two primary rows left. The tubercles there are of larger size than those represented in our fig. 3.

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* A fifth and, rarely, even a sixth, is interposed in some specimens at the actual margin, but not continued much above or below it.

"The base is concave, and the mouth is central and placed in a considerable depression. It is of moderate size, about one-fifth the diameter of the test" in half-grown specimens, but less in the adult. It is ten angled, the notches equally deep, but in pairs nearer together beneath the interambulacrum than at the avenues.

The plates of the disk are absent in all our specimens. They appear, however, to have been depressed. From the figures given by Agassiz of the closely allied Swiss species, the disk must have been oblong, the two posterior lateral ovarian apertures being placed rather wide apart, and the hinder one absent. The anal aperture is very large, and in our specimens being confounded with the space left by the disk plates, its shape cannot be very well ascertained. It occupies in adult specimens full half the length of the odd interambulacrum, and appears to be oblong-oval rather than pyriform. Its sides are incurved, but the depression in which it lies does not extend further* than the anus itself, although the tumid ridge on each side of it continues for some way down. In young specimens the anal opening is very much smaller, and proportionally narrow. "The spines adhering to this specimen are short, needle shaped, and delicately striated." (Wright, l. c.)

Variations.—We have figured Dr. Wright's very fine specimen, which is unusually large and has the tubercles more conspicuous than common, nor has it any convexity in the ambulacra beyond what arises from their forming the angles of the pentagon. Other specimens from the same locality agree with it in nearly all respects, but have the tubercles of less size and more numerous, twenty-four in a row across the interambulacra, and as many as six at the ambulacral margin. If this variety had a truncated posterior margin it would be the *P. Morrisii*, Wright, a very closely allied species. In others the form is slightly more pentagonal, and in one extreme variety the form is as angular and the sides of the pyramid as flat, as in the species next to be described (*P. conoideus*). But the tubercles are large, not minute, and the ambulacra though elevated have not sunk avenues, as in that species. The base occasionally is not flat, but undulated, the interambulacra being tumid on the lower surface.

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* This is one of the many characters in which our species differs from the bad figure of *Galerites umbrella*, given in the Encyc. Méthodique, and which has been quoted again and again by Agassiz as a synonym of his *Pygaster umbrella*, a species closely allied to the one here described.

The variation observable in the young state, viz., that the anal opening is very small and narrow, has before been adverted to. Only the two primary rows of tubercles in each area show distinctly when the specimens are but half an inch across.

Affinities.—"*P. semisulcatus* most nearly resembles *P. umbrella.** We have before us specimens which are well represented by Agassiz's figure, but the loss of the tubercles from the Swiss specimen leaves the question of their identity an open one." (Wright.) And we may add, that in the Swiss species the anal opening is larger and more pyriform, and the tumid ridge on either side of it is absent. But it appears to be present, to judge from the profile, in *P. patelliformis*, figured by Agassiz in the same plate (Ech. Suisses, tab. 13, f. 1–3.), a species in which we can scarcely see any character which should sufficiently separate it from *P. semisulcatus*, unless it be the breadth of the ambulacra and the continuation of their inner rows of tubercles higher up than in ours. The anus is certainly larger and seems to be pyriform rather than oval-oblong. This last difference may be sufficient to distinguish the two species, and it is accordingly inserted in the specific character. *P. laganoides*, Agass., figured in the same work, and in Desor's Monograph, is even more like, especially in the form of the anus, which is also placed in a depression along with the plates of the disk. The greater breadth of the ambulacra, the larger size of the mouth, and the much closer and more regularly placed tubercles, however, prevent us from uniting it with ours. *P. tenuis* of Desor's Monograph, tab. 12. f. 1–3., is so very like in the arrangement of the tubercles, narrow ambulacra, and sunk mouth, that but for the more depressed shape and large anal opening, which too, is not flanked by tumid ridges, it might be identical. It is from the Jura, in the "Terrain à Chailles."

History.—The list of synonyms was all that was left regarding this species by Professor Forbes, and in deference to him the reference to *Galerites umbrella* of Lamarck would have been retained, but that there is evidently a mistake altogether about that species, which is a *Nucleolites*, and not a *Pygaster;* and the quoting of it at all by Agassiz was probably an accidental error, which has been copied by himself and others without looking to the original figure of Klein.* Lamarck's description indeed might probably be mistaken for that of a *Pygaster,* as he distinctly says "*sulcis ambulacrorum angustis biporosis,*" but he adds, "*substriatis,*" and the figure shows broad avenues with the pores connected by transverse furrows; in fact, it is much like some forms of the common *Nucleolites* (*Clypeus*) *patella,* though probably a distinct species.

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* Now *P. dilatatus*, Ag., Cat. Raisonné, l. c., p. 144.

Prof. Buckman's notice, in 1845, of *Clypeus ornatus,* from the Oolite of Cheltenham, recalls the general form and markings of the species, though his specimen, as usual, having lost the plates of the disk, he makes a mistake in supposing the anal opening to have been at the vertex, the broad sinus extending from it halfway downwards being the aperture in question.

"The figure given by Phillips in 1829 without a description is a mere outline, two-thirds the natural size, without details of structure, but sufficiently like for identification. It is said, at p. 104, to be common to the Coralline Oolite and Calc. Grit, in Yorkshire and Oxfordshire."—(Forbes.) Phillips' species was admitted by Desmoulins in his Catalogue of Echinoderms, and considered by him a *Nucleolites.* Agassiz, in his Prodromus, placed it in the genus *Pygaster,* under which name it has been included in the new edition of Lamarck (1840), and in Desor's 'Monograph of the Galerites' (1842). The latter author considered it (p. 76, 77) as probably the young state of the *P. umbrella,* not being aware that Phillips' figures were so much reduced. But he, strangely enough, quotes with it as synonyms of the *P. umbrella,* the old references given by Lamarck to the figures in the Encyclopédie, and those of Plott, Klein, and Leske, while he takes some pains in the text to show how wrongly it has been arranged as a *Nucleolites* by the side of the *N. patella.* This confusion has only been partly remedied by himself and Agassiz in the Cat. Raissonné, the reference to *Galerites umbrella* still being retained for a French species of *Pygaster*, while the *P. umbrella* of the Ech. Suisses is altered to *P. dilatatus*. No mention is made of the *P. semisulcatus* of Phillips.

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* It is remarkable that Agassiz should have repeated this mistake in rectifying the synonyms of *Pygaster* in the Catal. Raisonné. Klein's figure of *Clypeus sinuatus,* from a specimen in the Dresden Museum, is better than the copy in the Encyc. Méthod., and shows the broad avenues more plainly. Leske compares it with the common English *Nucleolites,* which he calls *C. Plottii,* and says it has a more depressed form. They are apparently different species.

Dr. Wright, Annals Nat. Hist. for 1852, gave the first real description of the British species, distinguishing it carefully from the two other British forms, while with good reason expressing doubts as to its identity with the Swiss species, of which only a cast was published. In Morris's Catalogue, second edition, Professor E. Forbes adopted the present name, quoting Agassiz's *P. umbrella* only as a synonym. This course we are bound to follow in this Decade, for even if Agassiz's species should prove identical, it will be necessary to keep Phillips' name, since the old reference to Lamarck is undoubtedly erroneous.

Locality and Range.—GREAT OOLITE, Minchinhampton, Gloucestershire (Dr. Wright); Whitwell, Yorkshire, (in CALC. GRIT Phillips), but probably, "GREAT OOLITE" (Dr. Wright). See note at end of next description. INFERIOR OOLITE, Crickley Hill and Cheltenham, in the "Pea Grit," (Id. and Coll. Geol. Survey.)

FOREIGN DISTRIBUTION—doubtful. If *P. patelliformis* (*P. umbrella* of Agassiz) be identical, it occurs in the Kimmeridge Clay of the Jura Soleurois.

EXPLANATION OF PLATE VII.

Fig. 1. A fine specimen full grown, from the Inf. Oolite, Cheltenham, (Dr. Wright).

Fig. 2. Posterior view of do., showing the four rows of ambulacral tubercles towards the margin.

Fig. 3. Part of under side.

Fig. 4. Plates and avenues, with pores in single file.

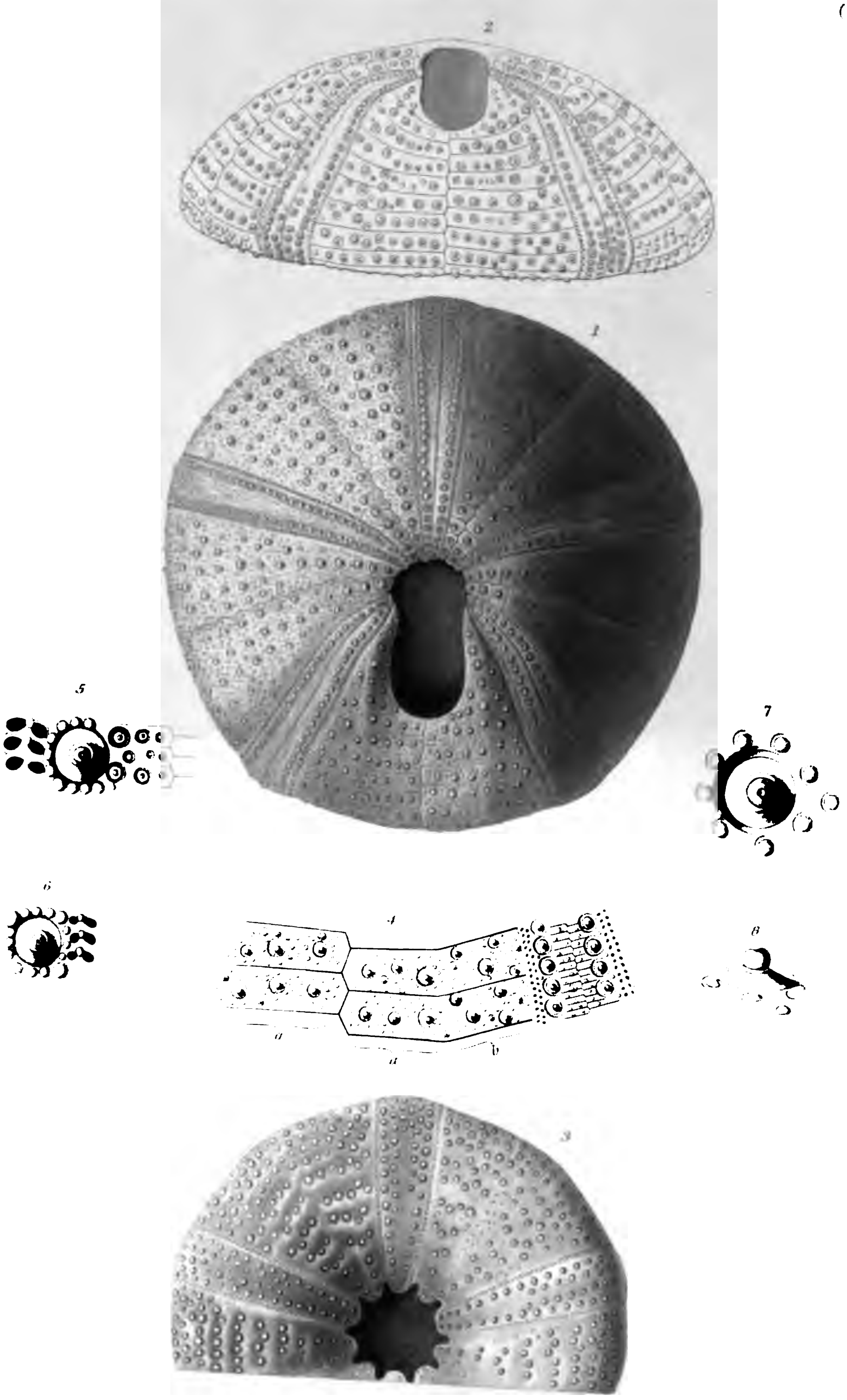
Fig. 5, 6. Primary and secondary ambulacral tubercles, with the usual number of pores opposite to them. The pairs of pores are somewhat divergent.

Fig. 7. Interambulacral tubercle, with its surrounding granules.

Fig. 8. Side view of the same. The area is scarcely sunk enough round the margin, in this figure.

J. W. SALTER.

March 1856.



PYGASTER SEMISULCATUS. *Phillips.*

BRITISH FOSSILS.

DECADE V. PLATE VIII.

PYGASTER CONOIDEUS.

[Genus PYGASTER. AGASSIZ (1834.) (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Cassidulidæ.) Orbicular, depressed or sub-conic; ambulacra simple throughout; tubercles perforate (and crenulate ?), disposed in very regular series in both areas; anus very large, superior, generally placed near the plates of the disk; mouth decagonal, no tubercles round it.]

DIAGNOSIS. ***P. pyramidalis pentaedrus, margini postico subacuto; tuberculis minutis et ut sparsis, subtùs majoribus et crebris; ambulacris elevatis, angustis: ano modico, nec dimidium interambulacri planati efficiente.***

SYNONYMS. *Pygaster conoideus*, WRIGHT, Ann. and Mag. Nat. Hist. (1852), vol. ix. p. 91. pl. 3. fig. 1.

The only cabinet that appears to contain this well-marked species is that of our friend Dr. Wright, who has lent it us for figuring. We may expect soon a full account from him, and of other British species not here mentioned, in the volumes of the Palæontographical Society.

It is more conoidal than any of its genus, the anterior and lateral surfaces forming angles of from 50° to 55° with the base, and the posterior side an angle of about 42°. Its height is an inch and $\frac{3}{10}$, and its diameter nearly 2½ inches either way (Wright). The base is nearly flat so far as it can be seen. The ambulacra are narrow and prominent, and are placed at equal distances, each being less than one fourth the width of the intervening spaces. The three anterior radiate in straight lines from the depressed disk, which is lost in our specimen; the two posterior curve first outwards to avoid the edges of the anal opening, and then proceed straight to the margin.

The primary tubercles on the ambulacra are arranged in two rows along the margin, and are small and inconspicuous; there are about thirty-two on the upper face. Between these are two other rows, less regular, but reaching halfway up, or sometimes further, and near the margin one or even two rows are introduced within these. On the under side the tubercles increase much in size, and are in four regular rows. The areolæ are very flat and depressed round their margin, which is often faintly radiated; there is no appearance of crenulation on their upper edge. The boss is small and bead-like, and shows the perforation well. There is a circle of granules round each areola, and scattered equal-sized granules, without any secondary tubercles between, over the surface.

The avenues are narrow and rather sunk, the pores in very regular single file (not at all undulated as in *P. semisulcatus.*) Each pair consists of a transverse and an oblique one, not differing much in size, and separated by a small prominent ridge, not a tubercle. There are about three ambulacral plates to each primary tubercle, so that there are nearly ninety plates in a series on the upper face. The pairs of pores are a little more distant below.

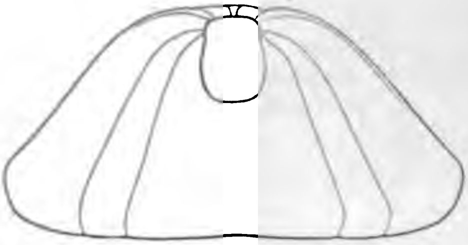
The interambulacral tubercles are like the others in size on the upper and lower faces; and their arrangement is very similar to that in the last-described species, viz., in transverse rows on the inner half of each ambulacral plate, and in scattered order on the outer portion, where they are decidedly larger, and, as our fig. 5 shows, often irregular; and sometimes they are absent. On the marginal plates there are often five tubercles in a row on the inner half, and three double rows on the outer, but above they are much fewer and less regular. About seventeen plates occur in an interambulacral series, much bent in outline, as shown in figure 5. The primary row (*a*) of tubercles occupies the median angle as usual.

The tubercles on the under surface are too wide apart in our figure. They are in irregular transverse rows, and their smooth depressed areolæ in some parts nearly touch, leaving room only for the granules between. We can see no trace of crenulation on the edges.

Affinities.—Except with the pyramidal variety of *P. semisulcatus*, before noticed, there is no species with which this can be compared. The small regular tubercles well distinguish it from that, and, together with the elevated ambulacra, seem to afford a good specific character. They are raised not only in the middle, but from their edges, and the avenues consequently sunk in a shallow groove.

PYGAST
(Oolitic)

3



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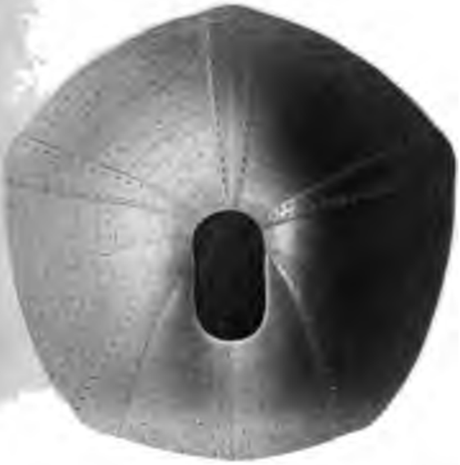

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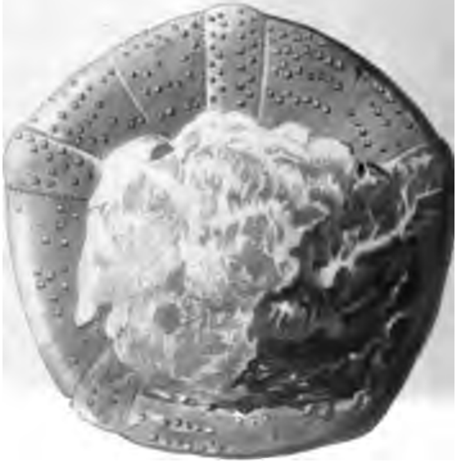
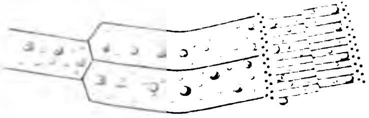


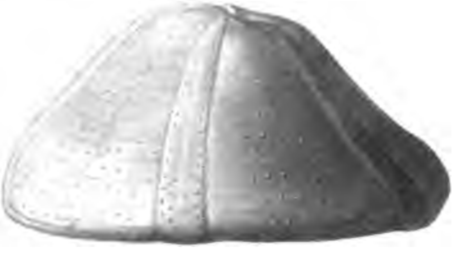


a

6

7

4



History.—Described by Dr. Wright in the paper above quoted, and admitted into Morris's Catalogue, 2nd edit. by Prof. E. Forbes. He left no notes upon the species.

Locality and Geographical Position.—INF. OOLITE, in the pea-grit of Crickley Hill, north of Cheltenham. Mr. Lycett's specimen came from the INF. OOLITE, near Stroud. (Dr. Wright.)

J. W. SALTER.

EXPLANATION OF PLATE VIII.

Fig. 1. Dr. Wright's specimen from Crickley Hill. Upper side; the disk plates lost, and the space occupied by them confused with the anal opening.
Fig. 2. Under side of do. only partly relieved from the stone.
Fig. 3. Posterior view, showing the height of the test.
Fig. 4. Lateral view, left side.
Fig. 5. Plates and avenues, with tubercles and granules.
Fig. 6. A tubercle from the interambulacral area, upper surface.
Fig. 7. Do. from the under side.

Other British Species of Pygaster.

As Dr. Wright will give a full description of this genus in his volume on the *Echinodermata* (Palæont. Soc. Trans.), it will be only necessary to notice the other British species very briefly. He has furnished us with the following memoranda:—

2. "*Pygaster Morrisii*, Wright, Annals and Mag. of Nat. Hist. vol. 9. 2nd series, pl. iv. fig 1.

"Test pentagonal depressed; marginal fold very tumid; single interambulacrum much truncated; ambulacral areas wide, convex, and prominent, with six rows of tubercles; interambulacra wide, with the tubercles in regular rows, from 20 to 22 rows at the equator; base depressed towards the mouth opening, which is small; anal opening large, occupying two-thirds of the dorsal portion of the single interambulacrum.

"*Locality.*—CORNBRASH, near Stanton, Wilts. (Dr. Wright.)

"3. *Pygaster umbrella*, Agassiz, Descript. Echinoderm. Foss. de la Suisse. part 1. p. 83. tab. xiii. fig. 4.

"Test large, very pentagonal, more or less elevated; ambulacral areas narrow, with two marginal rows of tubercles throughout, and two inner rows which commence at some distance from the peristome and extend only a short way above the marginal fold; interambulacral areas wide, with from 16—18 rows of tubercles at the equator; the tubercles are arranged in threes obliquely across the plates, and thus produce irregular rows; the anal opening is distinctly pyriform, occupying rather more than one-half the length of the dorsal surface of the single interambulacrum; base concave; mouth opening small; peristome decagonal, equal-lobed; tubercles on the base, larger, and more regularly arranged, than those on the upper surface.

"*Localities.*—CORALINE OOLITE, Calne, Farringdon, Malton; specimens from each of these localities are in the collection of Dr. Wright.

"The stratigraphical distribution of the four British Oolitic *Pygasters* is as follows:—

Pygaster semisulcatus,	Inferior Oolite and Great Oolite;
Pygaster conoideus,	Inferior Oolite;
Pygaster Morrisii,	Cornbrash;
Pygaster umbrella,	Coralline Oolite.

"It was an error in the determination of the species, which led Professor Phillips to state that *Pygaster semisulcatus* was found in the Coralline Oolite of Yorkshire, that form never yet having been found in Yorkshire out of the Whitwell beds,—Inf. or Great Oolite."

March 1856.

BRITISH FOSSILS.

DECADE V. PLATE IX.

HEMIASTER MURCHISONIÆ.

[Genus HEMIASTER. DESOR, 1840. (Sub-kingdom Radiata. Class Echinodermata. Order Echinidæ. Family Spatangaceæ.) Body obtusely cordate, tumid; dorsal ambulacra dissimilar, petaloid, lodged in depressions, and surrounded by a simple peripetal fasciole; tubercles of the dorsal surface small and similar; anus terminal, supramarginal; no sub-anal fasciole; mouth eccentric, bilabiate.]

DIAGNOSIS. *H. corpore tumido, ambitu subcordato; ambulacris dorsalibus profundis, postero-lateralibus brevissimis; fasciolâ latâ, evanescente.*

SYNONYMS. *Spatangus*, SMITH, Strat. Syst., p. 37. fig. 3., 'Brickearth' plate. *Hemiaster inæqualis*, FORBES, MS. in Morris's Cat. 2nd edit. p. 81. (not *Brissus inæqualis*, Forbes, Pondicherry Fossils, 1846, Trans. Geol. Soc. t. 7. p. 160. pl. 19. f. 6.) *Hemiaster inæqualis*, AG. and DESOR, Cat. 1847, p. 2. D'Orb. Prod. iv. p. 329.) *Micraster Murchisoni*, MORRIS, Cat., 1st edit. 1843, p. 55. BRONN, Index, p. 724. *Spatangus Murchisonianus*, MANTELL, 1835, Geol. Tr. 2nd ser. v. 3. p. 210, in part. DESMOULINS, Ech., p. 412. (not *Echinospatangus Murchisoniæ*, KÖNIG, Icones, 169. unpublished).

A memorandum in the handwriting of Professor Forbes suggests that this species might possibly be included in the group of Cretaceous urchins figured (but not yet described) by M. d'Orbigny, under the name *Epiaster*, and distinguished by the absence of any fasciole. The species of *Epiaster*, however, are rather to be regarded as Micrasters wanting the sub-anal fasciole, and in this group should be included the *Micraster cor-anguinum*, var. *gibbus*, of Decade III. pl. 10, f. 11, 12.

The specific name is applied in the belief that this is identical with the *Spatangus Murchisoniæ* of collectors, found in the upper Green Sand of Nurstead and Devizes, although not the species figured by König, which is nothing more than a crushed specimen of *Holaster lævis*.

Description.—The typical specimen (*a*) is extremely tumid, much more so than is represented (f. 3 and 4) in the plate. The measurements and number of ambulacral pores are accurately stated in the following memorandum by Professor Forbes:—

"In the British Museum are three specimens of this species from Blackdown. They differ from each other considerably in form, and in degree of depth of the dorsal ambulacra."

	A.	B.	C.
Length	$1\frac{8}{12}$	$1\frac{1}{12}$	$1\frac{1}{12}$
Breadth	$1\frac{6}{12}$	$1\frac{3}{12}$	1
Height	$1\frac{2}{12}$	$0\frac{11}{12}$	$0\frac{8}{12}$
Anterior ambulacra (pores)	28 pairs	26	24
Antero-lateral	43	36	30
Postero-lateral	20	22	16

The specimen B. is apparently adult, but dwarfish; and C. is a very young individual with the ambulacra but slightly impressed.

In the larger specimen the vertex is considerably behind the centre; the dorsal ambulacra are deeply impressed; the anterior sulcus becomes shallow at the margin, and is prolonged to the bilabiate mouth; the posterior end is slightly flattened, and nearly vertical; whilst in the smallest specimen it slopes at an angle of 73°. The vent is high up, small, and elliptical; the plates on each side of it have slight central prominences, converging to the caudal protuberance, beyond which on each side is a moderately projecting lateral boss.

The anterior ambulacral hollow is wide, finely granulated and tuberculate; the pairs of pores are separated by distinct tubercles. The lateral grooves are nearly smooth; the antero-lateral pair are shorter than the odd ambulacrum, and doubly curved; the posterior pair are less than half the length of the front pair. The spaces between the petals are pinched up near the apical disk, and more densely and roughly tuberculated.

The apical disk is composed of four perforated genital plates, of which the *right** antero-lateral includes the madreporiform body; there are five perforated ocular plates.

The surface of the test is very finely granulated above, with few scattered tubercles in the peripetal zone; the tubercles are more numerous and regularly distributed on the sides, becoming larger towards the base.

Affinities.—In its contour, and the form and proportions of its dorsal ambulacra, the *Hemiaster Murchisoniæ* agrees with the

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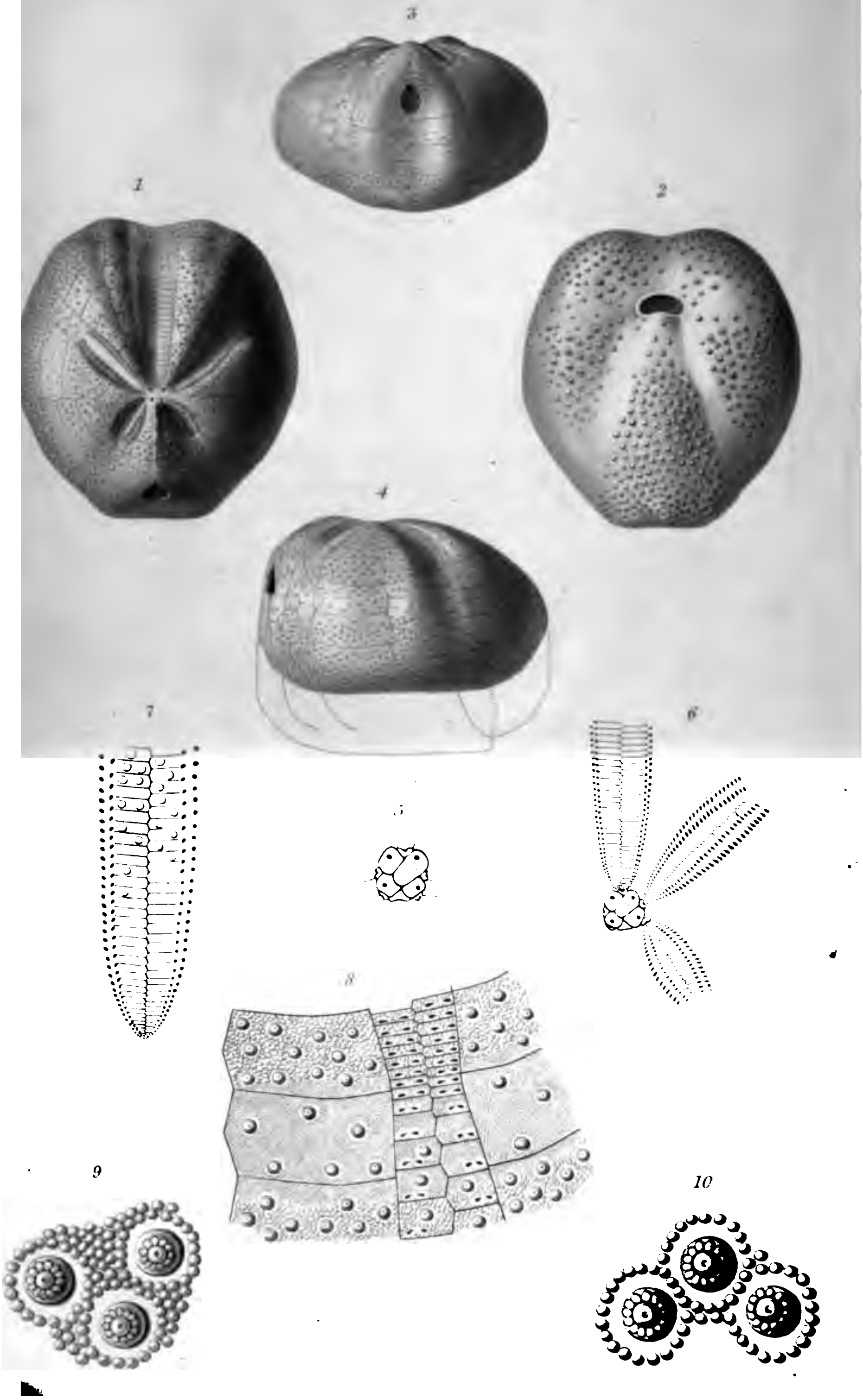
* Incorrectly stated to be the *left* in the description of *Micraster cor-anguinum*, Decade III.

gical Survey of the United Kingdom

DECADE X. PL. 9

HEMIASTE

(Cretaceous)



HEMIASTER MURCHISONIÆ — Mantell

typical species of the genus, and especially with the *H. Bailyi* of the Gault of Folkstone, from which it is only distinguishable by the absence of any proper fasciole. In *H. Bailyi*, the peripetal fasciole is narrow and distinct, being more finely granulated than the adjacent surfaces, although a very few tubercles are found encroaching upon it. In *H. Murchisoniæ* there is a very wide space surrounding the ambulacral petals, over which tubercles are more thinly scattered; the miliary granules in this band appear scarcely finer than over the rest of the surface, but this may be partly due to the condition of the specimens, which though silicified are slightly weathered. Ten specimens have been examined.

Locality and Formation.—At present this species is only known to occur in the GREEN SAND of Blackdown, Devon, where it is the only urchin of frequent occurrence.

DESCRIPTION OF THE PLATE.

Fig. 1. Upper view (of specimen in the British Museum).
Fig. 2. Under side of same specimen.
Fig. 3. Terminal view (of a more depressed example).
Fig. 4. Lateral view; the outline indicates the profile of specimen represented by figs. 1, 2. This figure (4) is represented as much too depressed, probably from being crushed, the dotted lines represent it more truly.
Fig. 5. Apical disk magnified.
Fig. 6. Details of the ambulacra.
Fig. 7. Anterior ambulacrum magnified.
Fig 8. Portion of the surface adjoining the right postero-lateral ambulacrum, magnified to show the diffused condition of the fasciole.
Fig. 9, 10. Tubercles of the lateral surfaces magnified.

Note on other British species of Hemiaster.

In addition to the *Hemiaster inæqualis*, Mr. Morris enumerates the following as species to be described by Prof. Forbes in the Fifth Decade :

Hemiaster asterias, Gault, Folkstone.
H. Bailyi, Gault, Folkstone.
H. Morrisii, Chalk Marl, Dover.

1. *Hemiaster asterias*, Forbes, Morris's Catal., 2nd edit. 81.

The specimens with this name attached are not in a sufficiently well-preserved state to admit of exact comparison and description (the best example being at Edinburgh, and at present inaccessible). The vertex appears to have been more prominent and further back than in the species figured, or in *H. Bailyi*, and the dorsal ambulacra may be longer and narrower in proportion.

Locality.—GAULT, Folkstone. (Mus. Pract. Geology.)

2. *H. Baylyi*, Forbes, MS. Morris's Cat., 2nd edit. p. 81. *Holaster argillaceus* (part), Morris's Cat., 1st edit. p. 54. *Echino-spatangus*, Mantell, Geol. Sussex, p. 86.

The specimens of this *Hemiaster* are all more or less crushed, but the most perfect agree in their proportions with the figured specimens of *H. Murchisoniæ*. One example, of the size of the figure, has the same number of ambulacral pores as specimen B., viz. 26, 36, 22. The *peripetal fasciole* is quite distinct, narrow, and simple in its contour, passing from end to end of the ambulacral petals, and only slightly contracted at the sides. The surface of the Gault urchins is usually rough, with nodular concretions of iron pyrites formed upon the tubercles. So many of the Blackdown fossils are identical with species of the Folkstone Gault, that we have felt considerable hesitation in admitting as specific, a character which may by any possibility be due to the mineral condition of the specimens.

Locality.—GAULT, Folkstone.

3. *H. Morrisii*, Forbes, MS. Morris's Cat., 2nd edit. p. 81. *Echinospatangus cordiformis* (part), Mantell, Geol. Sussex, p. 108. *Hemiaster punctatus*, D'Orb. Ter. Cret., pl. 886.? (no description). *Spatangus complanatus*, Mantell, Medals, 1st edit. p. 355. (not figured).

This not uncommon species has been long known to English collectors by a variety of incorrect names, but it is entirely distinct from any species with which we have been able to compare it, except the *Hemiaster punctatus* of D'Orbigny, the description of which has not yet appeared. The largest specimen of Dr. Mantell's measures in length 2⅛, breadth 2, height, 1⅜ inches. One of ordinary dimensions measures lon. 17, lat. 16, alt. 10 lines. The outline is oval and slightly polygonal; the anterior sulcus broad and obscure; the posterior end flat, and sloping at an angle of 70° (not vertical as in *H. punctatus*). The under side is but slightly flattened, the margins tumid, the vertex depressed and central. The ambulacral petals are small, moderately impressed, and surrounded by a distinct fasciole, which passes from point to point with scarcely any curvature. The surface, when well preserved, is rough with unequal tubercles, which are perforated, seated on crenulated bosses, and surrounded by a sharply-defined plain ring; they are so crowded as seldom to allow the formation of a complete circle of miliary granules.

Localities.—LOWER CHALK, Dover (Mus. Pract. Geol.) and Hamsey, Sussex (Brit. Mus. Mantellian Collection).

4. *H. bucardium*, Goldf. sp. (*sec.* Bronn, Index, p. 723.) *Micraster lacunosus*, Morris's Cat., 1st edit. p. 55. (not Parkinson).

This fine species is omitted in the second edition of the Catalogue of British Fossils; it agrees very well with the figures of Goldfuss. In the British Museum there is a single specimen of another species, equalling *H. bucardium* in size, and apparently undescribed.

Locality.—UPPER GREEN SAND, Warminster.

S. P. WOODWARD.

March 1856.

BRITISH FOSSILS.

DECADE V. PLATE X.

BRISSUS SCILLÆ.

[Genus BRISSUS. KLEIN. (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Spatangidæ.) Body oval or oblong, tumid; dorsal ambulacra subpetaloid, circumscribed by a peripetal fasciole; tubercles of dorsal surface all similar; anus terminal, supra-marginal; caudal extremity with a sub-anal fasciole.]

DIAGNOSIS. ***B. dense tuberculatus (tuberculis anticis majoribus) oblongo-ovatus elevatus nec inflatus, margini subcompresso; vertice excentrico; interambulacro postico plus minusve carinato; ano verticali; fasciolâ peripetali anterius sinuatâ et utrâque semel nec bis angulariter inflexâ.***

REFERENCE. *Scilla,* de Corp. Marinis, pl. 14. f. 2, 3. (*Spatangus placenta,* Philippi in Erichs. Archiv. for 1845, pl. 1. p. 349?) *Briss. Scillæ,* AGASSIZ and DESOR (1846), Ann. Sc. Nat., 3rd ser. tom. 8. p. 13. FORBES (1852), Palæontograph. Soc. Trans. (Ech. of the British Tertiaries) p. 15. pl. 2. fig. 4. in Morris's Catal., 2nd edit. (1854), p. 73.

"This sea urchin, one of the largest and most remarkable of all those found fossil in the crag, varies much in proportion, but is distinctly identical with Scilla's species, which lives in the Mediterranean, and occurs fossil in the Miocene of Malta. I purposely omit, however, all references to Lamarck, as there is sad confusion about this *Brissus* and its allies.

"*Description.*—The length of our fine specimen, presented to the Museum of Practical Geology by E. H. Bunbury, Esq., is 4$\frac{3}{12}$ inches, breadth 3 inches, height 2½ inches. The species varies much in shape, some specimens being oblong, some wide and ovate; the former are usually high, and strongly subcarinated on the back, the latter are more depressed; but all have the apex strikingly eccentric, and the *anterior** extremity abruptly truncated.

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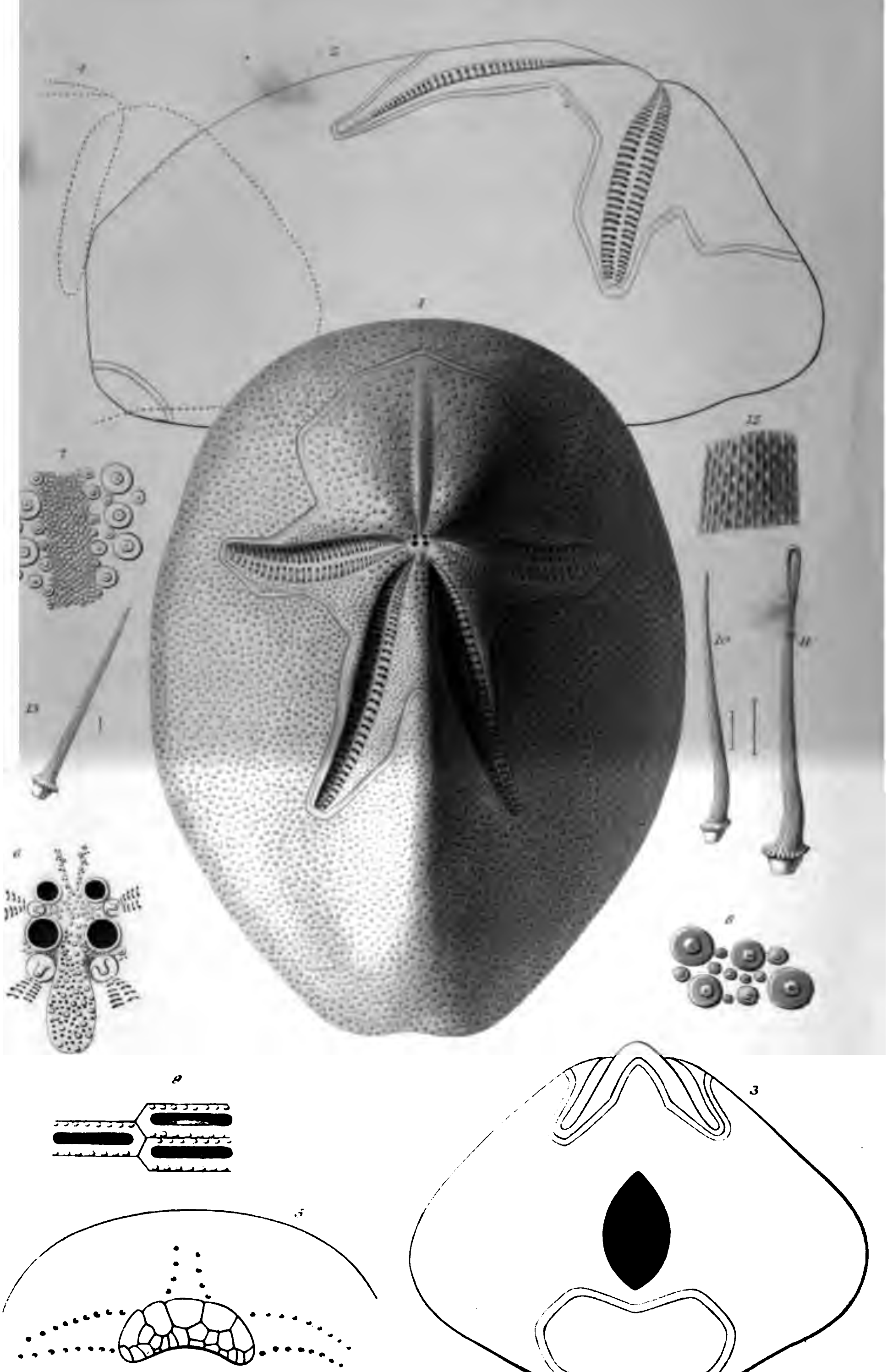
* Probably "posterior" was intended to be written here, but the word is preserved, as it is possible Prof. Forbes intended the steep slope of the anterior end. It can scarcely be called "truncated," much less "abruptly truncated."—J. W. S.



BRISSUS SCILLÆ. *Agassiz & Desor.*

ambulacral space, with an arched curve not so deeply inturned as the lateral curves are.

"The anal extremity of the test is perpendicularly truncated (a character also distinctive between this species and *B. carinatus*), the anus lenticular and large, and placed rather low down, and the sub-anal or caudal fasciole broadly obcordate, truncated below. The mouth is transversely semicircular, with a slightly overhanging and prominent lip. The oral ambulacra are subtriangular. The tubercles of the post-oral spinous region are subequal and radiating, and closer set than on the lateral spaces, or in front of the mouth."

Locality.—CORALLINE CRAG, Iken, Ramsholt, and Sudbourn, in Suffolk. (Mus. Pract. Geology, British Museum, &c.)

Foreign Localities.—MIOCENE, Malta (Prof. Forbes). (Mus. Pract. Geology.)

EXPLANATION OF THE PLATE.

Fig. 1. *Brissus Scillæ*, Ag., from Iken (Mus. Pract. Geology).
Fig. 2. Side view of do.
Fig. 3. End view, showing the anal opening and sub-caudal fasciole.
Fig. 4. Lateral view of another specimen, the vertex placed more anteriorly.
Fig. 5. Under view of recent specimen, to show the plates of the mouth.
Fig. 6. Genital openings and ocular plates, with the madreporic plate occupying the place of the fifth genital pore.
Fig. 7. Portion of peripetal fasciole, magnified.
Fig. 8. Tubercles and granules, magnified.
Fig. 9. Ambulacral pores, magnified.
Fig. 10–13. Spines more or less magnified.
Fig. 10. Is a lateral view, and 11, a front view of a spine with a spatulate tip.

March 1856. E. FORBES (1852).

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APPENDIX TO DECADE V.

BY S. P. WOODWARD, ESQ., BRITISH MUSEUM.

The Appendix contains descriptions of species referred to in the 2nd edit. Morris's Catalogue, for description in this Decade. To these one or two new species of the same genera are added, as also some additional species intended to be supplementary to descriptions in former Decades.

Genus CYPHOSOMA, Ag.—*Phymosoma* (D'Arch.), Desor.

1. *C. Königi*, Mantell (1822), Geol. Sussex, p. 189. *Cidarites variolaris*, Goldf., t. 40, f. 9 (not Brongn.) *Cyphosoma ornatissimum* (Ag.), Morris's Cat., 2nd ed., p. 75. *C. variolare*, Forbes, in Dixon, Fossils, p. x. pl. 25, f. 29. *C. Milleri* (Desm.), Forbes, in Dixon, p. 340, pl. 25, f. 26, 27. *Phymosoma Koenigii*, Desor, Synopsis, p. 86.

This species varies in diameter from less than an inch to two inches; small examples are rare. The spines are short, straight, and round, contracting suddenly, and sometimes bent and angular near the point. Long spatulate spines also occur, associated with the normal test.

Mr. Bowerbank's cabinet contains a remarkable monstrosity of this species, which is inversely conical, like *Diadema tumidum*. It is 9 lines high, and 16 lines in diameter above, contracting below down to the oral opening, which appears at first to be the summit.

Locality.—UPPER CHALK, Kent, Sussex, Norfolk, Wiltshire, Yorkshire.

2. *C. granulosum* (Cidarites), Goldf., Petr. t. 40, f. 7. Desor, Syn. p. 87. Probably only a variety of the preceding species.

The primary tubercles are larger and more prominent; the accessory tubercles are quite wanting in young specimens, and but slightly developed in the largest examples, which nearly equal the *C. Kœnigi* in size. The base is flat, or slightly convex from the peristome outwards.

Locality.—Most abundant in the LOWER CHALK of Kent and Sussex.

3. *C. spatuliferum*, Forbes (1850), in Dixon's Geology of Sussex, p. 340, pl. 24, f. 21. (Coll. Mrs. Smith, of Tunbridge Wells.) *Cyphosoma* sp. (junior), Dixon, Sussex, tab. 24, f. 28–31.

Body small, circular, and rough with numerous small prominent tubercles; lat. 10, alt. 4 lines; areolæ plain above, radiated below; base concave, mouth small, lat. 4 lines, apical opening pentagonal, irregular; pores in single file; ambulacral segments prominent, tubercles 8–10, largest at the circumference, with nearly confluent areolæ; interambulacral tubercles 9 in each row, bordered with very minute lateral tubercles, and divided by a conspicuous miliary furrow; spines very much flattened.

Locality.—Rare in the Upper Chalk of Kent and Sussex.

4. *C. tiara*, Ag., An. Sc. Nat., 1846, p. 351. Morris's Cat., 2nd ed., p. 75. *Cidaris tiara*, Hagenow. *Phymosoma saxatile*, Desor, Syn. p. 87.

"Nearly equally depressed above and below. A range of very inconspicuous secondary tubercles on the base, upon each side of the interambulacral areas, but disappearing at the circumference. Miliary tubercles very few. Pores reduplicate."—*Desor.*

This species was introduced into the English catalogues on the authority of M. Agassiz himself, but the specimen so named by Prof. Forbes appears to be only a casual variety of *C. Königi.* M. Desor's description answers best to *C. corollare.* He revives the name given to an urchin imbedded in flint, by Parkinson, who identified it with the living *Echinus saxatilis.* He also quotes Mantell's figure, which would be equally indeterminable, but that the specimen is preserved in the British Museum, and proves to be *C. spatuliferum.*

Locality.—Upper Chalk, Gravesend, Kent.

5. *C. corollare* (Park.), Forbes, in Morris's Cat., 2nd ed., p. 75.

Body circular, depressed, lat. 12, alt. 4 lines (usually smaller), base *concave*, oral opening small (lat. 4 lines), apical opening large, pentangular (lat. 5–5½ lines); pores crowded near the summit; primary tubercles small, with plain areolæ; interambulacral tubercles 9 in a row, with small irregular marginal and wide granular interspaces, becoming smooth above; ambulacral tubercles 9–11, tapering to either end. Spines long, slender, and spatulate, one-fourth longer than the diameter of the test.

Locality.—Very common in the Upper Chalk of Kent, and not unfrequently with the spines *in situ.*

6. *C. Wetherelli*, Forbes, in Morris's Cat., 2nd ed., p. 7.

Like *C. spatuliferum*; but the interambulacral tubercles bordered by prominent miliary granules, and by small lateral tubercles on the under surface only.

The unique typical example, partly imbedded in flint, was obtained at Gravesend, and presented to the Museum of Practical Geology by N. T. Wetherell, Esq., F.R.S. In the absence of further evidence, it can only be considered a variety of the last species.

Locality.—Upper Chalk, Gravesend.

7. *C. simplex*, Forbes, in Morris's Cat., 2nd ed. p. 77.

Body small, convex, lat. 9, alt. 4½ lines; base concave, mouth small; apical opening pentangular; primary tubercles prominent at the circumference, small and inconspicuous above; areolæ radiated, large and nearly confluent at the middle, very small above, and separated by a wide finely granulated miliary furrow; interambulacral tubercles 9, 10, with small laterals on the under surface; ambulacral tubercles 8, 8, with large confluent areolæ at the circumference. Pores in single file.

The test of this species is more highly ornamented than any of the preceding forms, but the upper surface appears nearly plain unless examined with a glass.

Locality.—Common in the hard gritty CHALK of Dover, and occasionally found in the CHALK with flints in Sussex.

8. *C. difficile*, Ag., Cat. Syst., p. 11. *Diadema rotatum*, and *D. M'Coyi*, Forbes, in Morris's Cat., 2nd ed., p. 76, 77. *Diadema rotulare*, M'Coy (not Ag.). *Glyphocyphus difficilis*, Desor, Syn., p. 104.

Body small, lat. 7, alt. 3 lines, convex above, slightly concave beneath; mouth circular, lat. 2½ lines; apical disk equal to the oral opening, flat, finely granulated; ocular plates rather large, perforated close to the ambulacral margin; genital plates perforated (with a sur-anal plate in the centre?), and the madreporiform body on the right anterior plate; poriferous avenues nearly straight, distinct, with the pairs of pores in single series; tubercles prominent, quite smooth unless weathered, placed on crenulated bosses; ambulacra narrow, straight, with remote alternate tubercles irregularly developed, 3, 8, or 7, 8; interambulacrals in two straight rows of 8, 9, surrounded by small strongly radiated areolæ, and divided by deep sutural notches.

Small specimens, measuring 4 or 5 lines, are abundant, and usually overlooked as the young of the *Diademas*, but may be readily distinguished by the sutural notches. The more convex examples agree with the published mould of M. Agassiz's type specimen of *C. difficile*, but there is nothing in the description of *C. sulcatum*, Ag., to distinguish it from the same urchin. An unusually large specimen (in the cabinet of Mr. Sloper, of Devizes) measures 9 lines across and 4½ in height; both rows of ambulacral tubercles are well developed, and the miliary granules form a prominent framework to the tubercles. Two specimens have occurred with the apical disk, one of which is in the Brit. Mus., and the other in Mr. Cunnington's Collection.

M. Desor refers this urchin to D'Archiac's *Glyphocyphus* (which was founded on the *Temnopleurus pulchellus* of Sorignet, *Echinopsis pusilla*, Rœmer, and incorrectly described as having the tubercles imperforate, and bosses not crenulate), but the structure of the apical disk is altogether different.

Locality.—CHALK MARL, Dover (Mus. Brit. and Tennant). UPPER GREEN SAND, Warminster.

9. *C. mespilia*, n. sp.

Body small, circular, inflated or depressed, convex above and below, with sub-equal apertures; lat. 5, alt. 3 lines; poriferous avenues quite straight and simple, pairs of pores very oblique; tubercles minute, prominent, imperforated, and crenulated; areolæ small, radiated, with elongated miliary granules, sutures grooved; interambulacra with two rows of 7, 8 tubercles; ambulacra very narrow, with 7 or 8 tubercles, alternate and irregular.

Locality.—Lower Chalk, Dover (Mus. Brit. and Bowerbank). This small but very distinct species has only been found in the hard White Chalk, along with *C. simplex* and *Salenia granulosa.*

10. *C. Middletoni*, n. sp.

Body circular, tumid, concave beneath; lat. 10, alt. 6 lines; mouth small, depressed, lat. 3½ lines; apical opening pentagonal, elongated, lat. 4–5½ lines; pores in single file; primary tubercles small, in sub-equal rows of 12 each, the 6 uppermost minute; areolæ large at the circumference, nearly confluent; interambulacral tubercles bordered above by 6 nearly equal accessories, and divided by a broad furrow, smooth in the centre; secondary tubercles also developed on the base.

Locality.—Upper Chalk, Norwich. This unique specimen was placed in the hands of Prof. Forbes, for description, by John Middleton, Esq., of Norwich.

Salenia, Gray.

In the 2nd edition of Prof. Morris's Catalogue of British Fossils, p. 89, the following species of *Salenia* are referred to, as described by Prof. Forbes in Decade V. No MS. having been left, the following notes are drawn up from the type specimens in the Museum of Practical Geology.

1. *Salenia Austeni*, Lower Chalk, Dover.
2. *S. Bunburyi*, Lower Chalk, Mildenhall.
3. *S. Clarkii*, Lower Chalk, Dover.
4. *S. clathrata* (Ag. MS.), Upper Green Sand, Warminster.
5. *S. granulosa*, Lower Chalk, Dover.
6. *S. Portlockii*, Upper Chalk, Ireland.
7. *S. umbrella* (Ag. MS.), Upper Green Sand, Warminster.
8. *S. ornata* (Ag. MS.), Upper Green Sand, Warminster (Decade I. 5, p. 2).

1. *S. Austeni*, Forbes, MS. Like *S. petalifera*, Desm.

Body tumid, depressed, lat. 10, alt. 6 lines; apical disk comparatively small, 5 lines in diameter; the plates ornamented with serrated ridges running in pairs from their centres, and meeting to form a sort of trellis.

Two of the original specimens, in the Museum of Practical Geology, are more distinct from *S. petalifera* than any other examples. The apical disk of *S. petalifera* is very finely granulated, but, as remarked by Prof. Forbes (Decade I. 5, p. 3), "a few rare specimens exhibit indistinct indications of radiated ribbing." In the Grey Chalk of Dover, some examples are nearly plain, others highly ornamented, but never two alike. The sutural pores appear more numerous in the sculptured specimens, there being 5 to each ocular plate.

Locality.—LOWER (or GREY) CHALK of Dover.

2. *S. Clarkii*, Forbes, MS.

Body 6 lines in diameter, 4 in height; apical disk rather small, scarcely exceeding 3 lines in diameter, the plates rough, with raised points; each genital plate with five furrows leading to the sutural pores, which are like those of *S. petalifera*, but larger; ambulacra rather narrower than in *S. petalifera;* spines slender, cylindrical, finely striated and granulated, the longest exceeding 1¾ inches in length, and less than 1 line in diameter, frequently forked at their extremities, and sometimes bent and distorted.

This species is scarcely to be distinguished from those Warminster specimens which have been referred to *S. gibba*, Ag.; but is entirely distinct from the *mould* of M. Agassiz's original example.

Locality.—GREY CHALK, Dover. (Mus. Pract. Geol. and Brit. Mus.)

3. *S. granulosa*, Forbes, MS. Morris's Cat., 2nd ed. p. 89. *S. scutigera?* Forbes, in Dixon's Geol. Sussex, t. 25, f. 24.

Body small, lat. 6, alt. 3½ mill.,—sometimes it measures only 1½ lines in diameter; oral opening large, not depressed; apical disk very large, lat. 4½ lines, plates finely sculptured with rugose lines, sometimes radiated, sutures quite simple; primary tubercles few and prominent; miliary zone irregular, granulose; ambulacra narrow.

Locality.—LOWER CHALK, Dover. Found along with *Cyphosoma simplex* and numerous *Bryozoa*, in the hard gritty beds of White Chalk. (Mus. Pract. Geol., Brit. Mus.)

4. *S. Portlockii*, Forbes, MS. Morris's Cat., 2nd ed., p. 89. *Cidaris vesiculosus*, Portl., Geol. Rep., t. 18, f. 5. *S. scutigera?* Forbes, Dixon's Sussex, pl. 25, f. 23. *S. geometrica*, Ag., Mon. d'Ech. Salenies, p. 11, t. 1, f. 25-32.

Body subglobose, elevated, convex above, contracted and concave beneath, lat. 9, alt. 8 lines; mouth small, lat. 3 lines; apical disk moderate, lat. 6 lines; plates slightly radiate; sutural perforations rather indented; ambulacra narrow, sinuous, tubercles separated by two rows of granules; interambulacral tubercles 7-8, those near the mouth (3, 4) very small; miliary zone wide.

The specimen described belongs to Mr. Searles Wood; another, in the cabinet of Mr. John King, of Norwich, measures 11 lines in height, and the same in diameter; and there is a fine specimen in the Hunterian Collection. The agreement of this species with *S. geometrica* has been overlooked on account of an error in the figure given by M. Agassiz; the published *mould* is quite like our fossil:—"L'espace entre les deux séries de gros tubercles est parsemé, comme dans l'espèce précédente (*S. petalifera*), mais en nombre moins considerable, de très-petites granulations, qui ont été omises par erreur dans le dessin."

The *Cidaris acrocidaris*, Portl., from the Irish Chalk, is a flint cast of a small *Salenia* resembling that figured in Dixon's Geology of Sussex, pl. 25, f. 25. It may be the cast of one of the un-named species (of which there are several in the British Museum) found in Scania and at Ciply.

Locality.—This beautiful species occurs in the CHALK of the North of Ireland, and, very rarely, in the UPPER BEDS OF CHALK at Norwich, and in Sussex. It is also found at Havre. *Flint casts* are not uncommon in the gravel of Norfolk.

5. *S. clathrata*, Ag., MS. Morris's Cat., 2nd ed., p. 89.

Body subglobose, very convex above; lat. 6, alt. 4½ lines; apical disk lat. 5½ lines, nearly covering the upper surface, its outline very deeply indented between the ocular and genital plates; anal opening with a very prominent margin; plates smooth, deeply notched at the sutures, those connecting the centres of the plates forming a distinct pentagon, and each of the genital pores is the centre of five radiating grooves, with angular pits between; ambulacra narrow; tubercles few and prominent, separated by a narrow miliary zone.

The smallest specimens found at Warminster are very gibbous, and appear to be dwarfs, rather than young individuals. The species attains a large size in the Grey Chalk, and are occasionally more depressed, with the marginal lobes of the anal disk broader, and the sutural grooves less excavated. The name *S. umbrella* (Ag., MS.) appears to have been intended for those specimens with the sutural grooves most deeply and sharply defined. The figure in Parkinson's Organic Remains (vol. iii. pl. 1, f. 13), referred to by Prof. Forbes, in Decade I., as "*S. ornata*, Ag. MS.," is indeterminable.

Locality.—UPPER GREEN SAND, Warminster; GREY CHALK, Dover.

6. *S. Bunburyi*, Forbes, MS. Morris's Cat., 2nd ed., p. 89.

Body subglobose, tumid above, with a wide base, and depressed oral aperture; lat. 7, alt. 5½ lines; apical disk, 5½ lines in diameter, vent with a prominent thickened border, plates sculptured at the border of the disk, sutural notches forming deep linear grooves (as in *S. umbrella*); ambulacra narrow, sinuous, with small remote tubercles divided by a prominent granulated ridge; interambulacral tubercles 4, 5, prominent, divided by a wide miliary tract.

Locality.—LOWER CHALK, Mildenhall, near Bury St. Edmunds. The original and unique specimen in the Mus. Pract. Geol. was presented by E. H. Bunbury, Esq., M.P.

7. *S. punctata*, Desor.

This is the only British species belonging to the section *Peltastes*, Ag., in which the sur-anal plate is placed between the vent and the odd ambulacrum; a specimen in the late Dr. Mantell's Collection has the vent situated as in the normal Salenias.

Locality.—GREEN SAND, Farringdon. The specimen from the Kentish Rag of Hythe, presented to the Mus. Pract. Geol. by H. B. Mackeson, Esq., differs in no respect from Farringdon specimens of the same size.

Cardiaster grandis, Benett. sp., *Spatangus grandis*, Benett (1831), Cat. Org. Rem. Co. Wilts, p. 7. (S. Woodward, 1835. Monograph of Brit. Fossil Echinidæ. MSS. in Mus. Pract. Geol.)

Oblong, cordiform, inflated; vertex moderately elevated, anterior sulcus rather deep; lateral ambulacra not impressed, pores symmetrical; primary tubercles regularly distributed and equal in size above the lateral fasciole, rather more crowded below, and larger on the under surface; the upper is densely covered with miliary granules, leaving annular spaces round the tubercles; post-oral spaces elongated, covered with rather larger tubercles, surrounded and divided by single rings of granules. Lon. 3¼; lat. 2¾; alt. 2 unc.

Locality.—UPPER CHALK, Norwich (Coll. J. King). "Chalk and Flint, Heytesbury, Wilts." (Mus. Benett; Brit. Mus.)

Cardiaster Cotteauanus, D'Orb., Ter. Cret., pl. 830.

Locality.—Mr. Baily has recognized the occurrence of this species in the UPPER CHALK of Kent. There are two specimens from Dover in the Museum of Pract. Geol., and one considerably smaller, and somewhat different, from the UPPER GREEN SAND of Warminster, in the British Museum.

Epiaster crassissimus, D'Orb., Ter. Cret., pl. 860.

A specimen in the Mus. Pract. Geol., from the hard GREY CHALK of Dover, only differs from D'Orbigny's figure in being more depressed. Another species, from the UPPER CHALK of Dover, in the Brit. Museum, has extremely small and scarcely impressed ambulacral petals; the surface is perfectly preserved, but exhibits no fascioles.

Micraster Mantelli, Forbes, MS. Morris's Cat., 2nd ed., p. 83.

The specimens with this name attached do not differ in any respect from those recognized as the young of *M. cor-anguinum*; at this age they are always very tumid, and the dorsal ambulacra are scarcely at all impressed.

Locality.—UPPER CHALK of Dover and Kent.

S. P. WOODWARD.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE VI.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

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BRITISH FOSSILS.

DECADE THE SIXTH.

THIS the Sixth Decade of representations of British Fossils is devoted to the illustration of some new genera and species of extinct fishes.

The comparative rarity of these fossils renders it impossible to conform to the plan adopted in the preceding Decades of grouping the subjects either according to natural relations or stratigraphical position. The same cause precludes also the possibility of selecting from the collections of the Geological Survey a sufficient number of novelties to complete a Decade.

In accordance, nevertheless, with the request of the Director General, that I would undertake the production of an Ichthyological Decade, I have accomplished the task by selecting subjects from my own cabinet and elsewhere, either entirely new, or little known, none of which have hitherto been figured.

Of these the most interesting is the unique chalk ichthyolite in the collection of the British Museum, described in the last article. The other descriptions comprise a new *Palæoniscus,* from the coal-measures; new species of the genera *Lepidotus, Pholidophorus, Ptycholepis,* and *Leptolepis,* from the Oxford clay and lias formations; an *Ophiopsis,* from the Purbeck strata, near Tisbury; and a detailed account of a *Chimæroid* fish, *Elasmodus Hunteri,* from the London clay.

The curious structural details of the latter specimens are beautifully delineated in the first copper-plate. The same process of illustration was attempted for the other plates, but the time and labour requisite to produce satisfactory results proved to be so great, that, after the completion of one plate, No. 3 of the Decade, it was considered advisable to have recourse to lithography for the the remainder.

These lithographs have been so beautifully drawn by Mr. Dinkel, that I trust the result of the experiment may be considered sufficiently satisfactory to warrant the employment of this style of illustration in any subsequent Decades devoted to this branch of British Palæontology.

P. DE M. GREY EGERTON.

April 8, 1852.

BRITISH FOSSILS.

DECADE VI. PLATE I.

ELASMODUS HUNTERI.

[Genus ELASMODUS (ἔλασμα, a plate, and ὀδοὺς, a tooth). EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Sub-class Elasmobranchii. BONAPARTE. Order Holocephali. MÜLLER. Family Edaphodontidæ. OWEN.) Lower maxillaries having one tritor on each structure composite, partly of bone, partly of laminated dentine; upper maxillaries bony, intersected by a scroll of laminated dentine forming the outer margins, and a double tritoral tooth on each; premaxillaries composed wholly of laminated dentine.]

SYNONYMS.—*Chimæra Hunteri*, OWEN, Odontography, (1840-45), p. 66
Elasmodus Hunteri, EGERTON, Proceedings of Geol. Soc., 1843.

Description.—The dental apparatus of *Elasmodus* is so complicated in its structure, that it is a task of some difficulty to communicate to the reader an exact idea of its many peculiarities. However adroitly this may be accomplished, an inspection of the clear and faithful representations given in the plate will convey a more accurate notion of these curious fossils than any verbal description. The arrangement of the several tissues constituting the lower jaw is as follows:—The anterior portion, comprising nearly one third (figs. 1, 2, *a.*), is composed of a series of laminæ of coarse dentine, superimposed on one another in the following manner. At the symphisis the plates incline downwards and outwards, while on the external front they maintain an horizontal direction for one half their extent, and then slope downwards and backwards to their termination. These are succeeded by a vertical band of coarse fibrous bone (figs. 1, 2, *b.*) occupying the middle third of the jaw. The posterior third (figs. 1, 2, *c.*) has its outer wall composed of a series of vertical columns of laminated dentine, the points of which give to this part of the cutting edge a notched and irregular outline as in the recent *Chimæra monstrosa*. Between this columnar portion and the bony band a thin line of dentine (figs. 1, 2, *d.*) occurs, formed by the continuation of the inner edge of the large triturating tubercle, which traverses the entire substance of the bone. The tubercle itself is composed of dentine, and occupies a considerable part of the internal surface of the jaw, and extends from the crown to the base (fig. 2, *e*.) In structure it closely resembles the analogous tritores in the genus *Edaphodon*. Both the outer and inner surfaces of the jaw, with the exception of this dentinal plate, were invested with a layer of harder material, as in the genus *Ischyodus*. The remarkable laminated structure, which suggested the generic name, obtains in the upper as well as in the lower jaw. As in the other *Chimæroids*, *Elasmodus* was furnished with two upper maxillary bones, and two premaxillaries. The former were provided with three triturating tubercles (fig. 6, *a*, *b*, *c*.) as in *Edaphodon*; but, unlike those of the latter genus, the dentine of which they are composed is confluent, being rolled round, like a scroll, in the substance of the bone; one edge forming the margin of the tooth, the other buried deep in its centre. In the young *Elasmodus* (figs. 7, 8.) the two principal tubercles were united at their bases. The premaxillaries (figs. 9, 10.) are thin, incurved, scalpriform denticles, rounded at the cutting edge. They have the lamelliform structure characteristic of this genus, but correspond with the premaxillaries of the allied genera in the columnar arrangement of the plates, although the columns are not separated by septa of bone.

History.—It was not likely that any organic body, exhibiting peculiarities of structure such as are here detailed, should be passed by unheeded by John Hunter. The specimens figured of the lower maxillaries and the premaxillaries (figs. 1, 2, 9, 10.) are in the Hunterian collection. Shortly after Dr. Buckland's ingenious discovery of the affinities of the fossil *Chimæroids* of the oolitic and cretaceous formations, these specimens attracted the notice of Professor Owen, who recognised their true character, and described them under the name of *Chimæra Hunteri*.* In the course of my examination of the *Chimæroid* family in 1843, I proposed to eliminate these forms under a separate generic title, an arrangement which the subsequent discovery of the upper maxillaries fully confirms. The latter were found by the late Mr. Dixon at Bracklesham, and fortunately show the peculiarities of the dental arrangement both in the young and the adult individual.

Affinities.—The genus *Elasmodus* approaches nearer to the recent *Chimæra monstrosa* than either *Ischyodus* or *Edaphodon*, in the form and structure of the lower jaw, and the premaxillaries; but in every other respect its nearest affinity is with *Edaphodon*.

Localities.—This species is found in the Eocene formations of the

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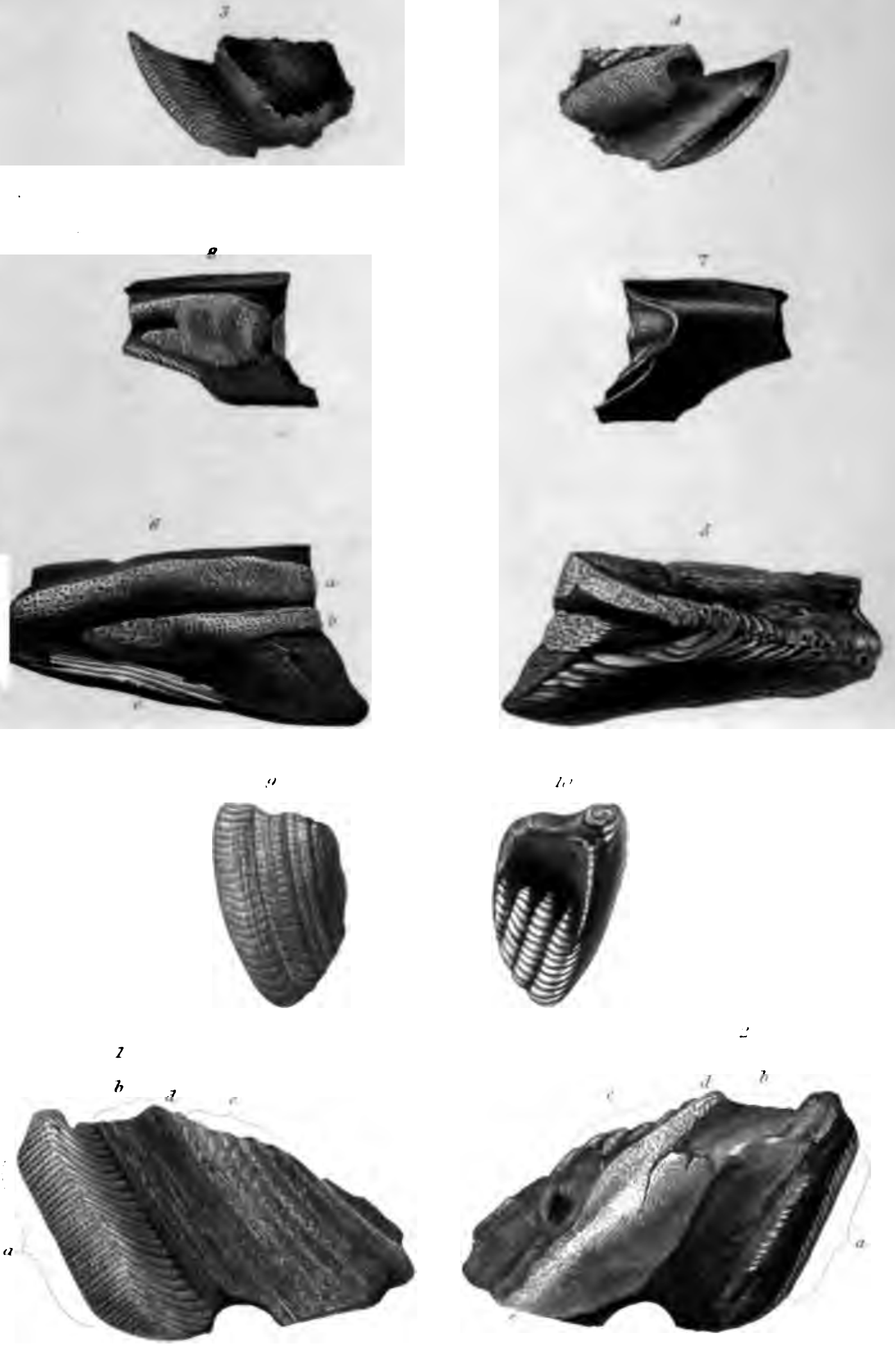
* Odontography, p. 66.

ELASMODUS
(Tertiary)



ELASMODUS HUNTERI.. *Egerton.*

Isle of Sheppey and Bracklesham bay. The specimens selected for illustration are in the collections of the Royal College of Surgeons, and the late Mr. Dixon of Worthing.

EXPLANATION OF PLATE.

Fig. 1. Outer view of the lower jaw.
Fig. 2. Interior view of the same.
Fig. 3. Outer view of the lower jaw (young).
Fig. 4. Interior view of the same.
Fig. 5. Upper view of the superior maxillary plate.
Fig. 6. Under view of the same.
Fig. 7. Upper view of the superior maxillary (young).
Fig. 8. Under view of the same.
Fig. 9. Outer view of the premaxillary denticle.
Fig. 10. Interior view of the same.

P. DE M. GREY EGERTON.

probably not more than 9 inches in length by 2¾ inches in depth, and bears undoubted marks of mature age in the successive lines of growth engraven on the surfaces of the scales. The head is imperfect, but from what remains it seems to have been longer and narrower than in *Lepidotus minor*. A mutilated dorsal and ventral fin are the only natatory organs preserved. The former is smaller and less powerfully constructed than is usual in the *Lepidoti;* the fulcral scales are shorter and narrower, and the fin rays more arched than in *Lepidotus minor;* the latter is situate rather nearer the head than in that species. The trunk is more slender than in any of the genus, and affords an unmistakeable characteristic of the species; but in addition to this we find in the scales such clear specific indications, that they could be recognized in the most imperfect and fragmentary condition. Those on the anterior part of the body are larger in the vertical than in the longitudinal direction; about the flanks these dimensions are nearly equal; while in the vicinity of the tail the longitudinal diameter is the greatest. They have the upper border convex, and the lower one concave on the greater portion of the body, which gives a remarkable undulating character to the cephalo-caudal series. The dorso-ventral series are more oblique than in *Lepidotus minor*, and the joinings of the scales in the succeeding columns fall nearer the centres of the scales of each antecedent series. They contain about sixteen scales in each. These are characterized by delicate radiating striations which give a pectinated edge to the posterior margin of the scale. The striations disappear in the caudal region, and the scales are smooth with entire edges. In the young fish the striato-pectinate character seems to have existed to a greater extent than in the adult, as on some of the caudal series zigzag lines are still apparent, which at one period must have been the free margins of the scales.

Affinities.—In the proportion and character of the scales this species approaches the genus *Semionotus*.

History.—An unique specimen in the collection of the Earl of Enniskillen.

Locality.—Lias of Whitby, in Yorkshire.

EXPLANATION OF PLATE.

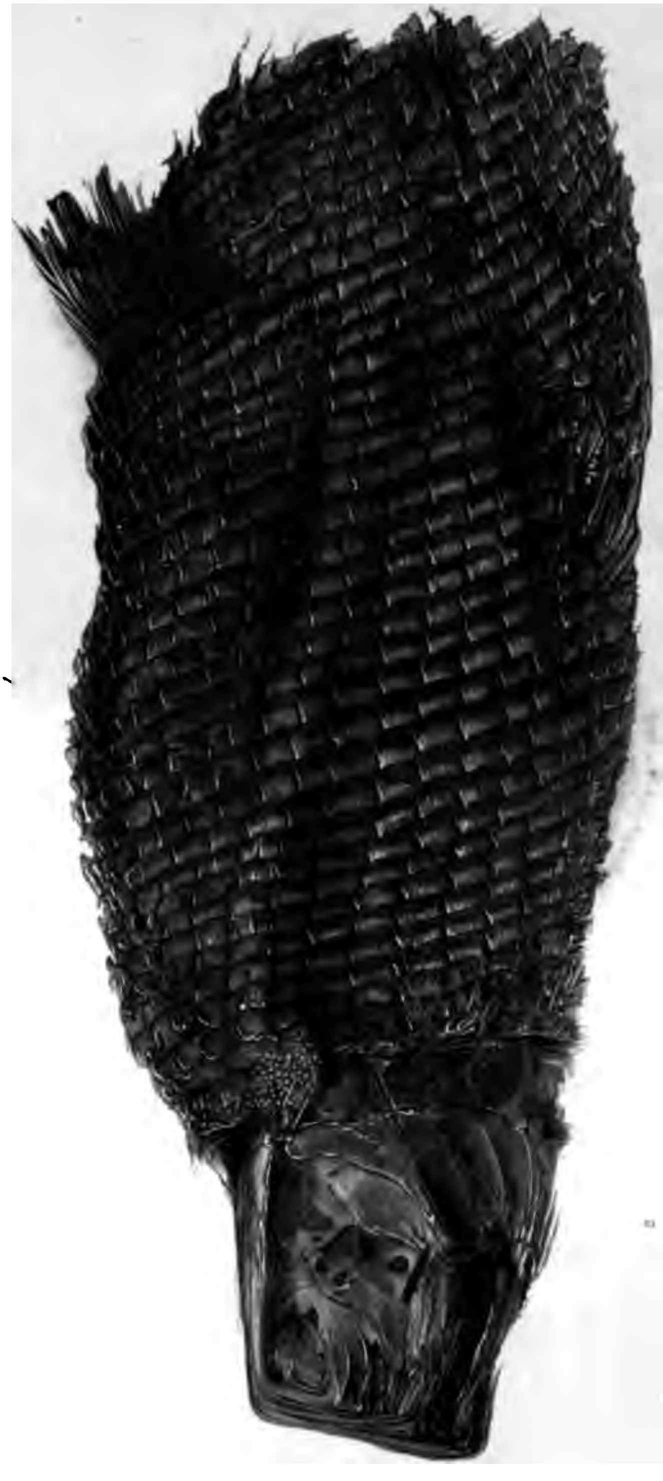
Fig. 1. Lepidotus pectinatus, size of nature.
Fig. 2. Scales, magnified.

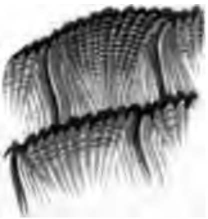
P. DE M. GREY EGERTON.

ical Survey of the United Kingdom.

DECADE 6.PL.

LEPIDOTU
(Oolitic)





LEPIDOTUS PECTINATUS *Egerton*

BRITISH FOSSILS.

DECADE VI. PLATE IV.

PHOLIDOPHORUS PACHYSOMUS.

[Genus PHOLIDOPHORUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2d Group. Body elongated, more or less fusiform.) Dorsal fin small, opposite the ventrals; caudal fin forked; the lobes equal; the base of the upper lobe invested with scales; teeth villiform.*]

Pholidophorus pachysomus, EGERTON.

Description.—This species is easily detected by its stumpy and inelegant proportions, which contrast strongly with the graceful forms of the associated *Pholidophori*. The head bears the proportion of 2 to 7, as compared with the length of the fish to the insertion of the caudal fin, whereas this measurement in *Pholidophorus Bechei* is as 1 to 4. The depth of the body at the dorsal fin is equal to one half of the length from the scapular arch to the tail. This unusual proportion gives an oval outline to the body, very distinct from the fusiform shape of the generality of the species. As compared with *Pholidophorus Bechei* the lower jaw is shorter and stronger, the orbit larger, and the surface of the opercular bones less uneven. The rays composing the pectoral fin are more slender. The space from the occiput to the insertion of the dorsal fin is much less, as is likewise the distance between the ventral fins and the tail. The other characters of the natatory organs correspond pretty nearly with those of that species. The scales are of large size, and perfectly smooth. The series, counting along the lateral line from the scapular arch to the tail, contain only 30 scales, being 10 less than are found in *Pholidophorus Bechei*. Those in the centre of the flanks are the largest. The posterior edges are curvilinear, and slope rather obliquely backwards and downwards; in some specimens they are translucent, in consequence of the thin plate of ganoine projecting beyond the opaque material of the body of the scale. The articulating processes of the scales are remarkable for their width and strength (Fig. 3.)

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* Poiss. Foss., vol. ii. p. 9.

Affinities.—This species most resembles *Pholidophorus Bechei.*

History.—The description is taken from two specimens in my possession. Lord Enniskillen has also a specimen of this species.

Locality.—Found in the lias at Lyme Regis.

EXPLANATION OF PLATE.

Fig. 1. The fish, natural size.
Fig. 2. The caudal vertebræ.
Fig. 3. Scales, magnified.

P. DE M. GREY EGERTON.

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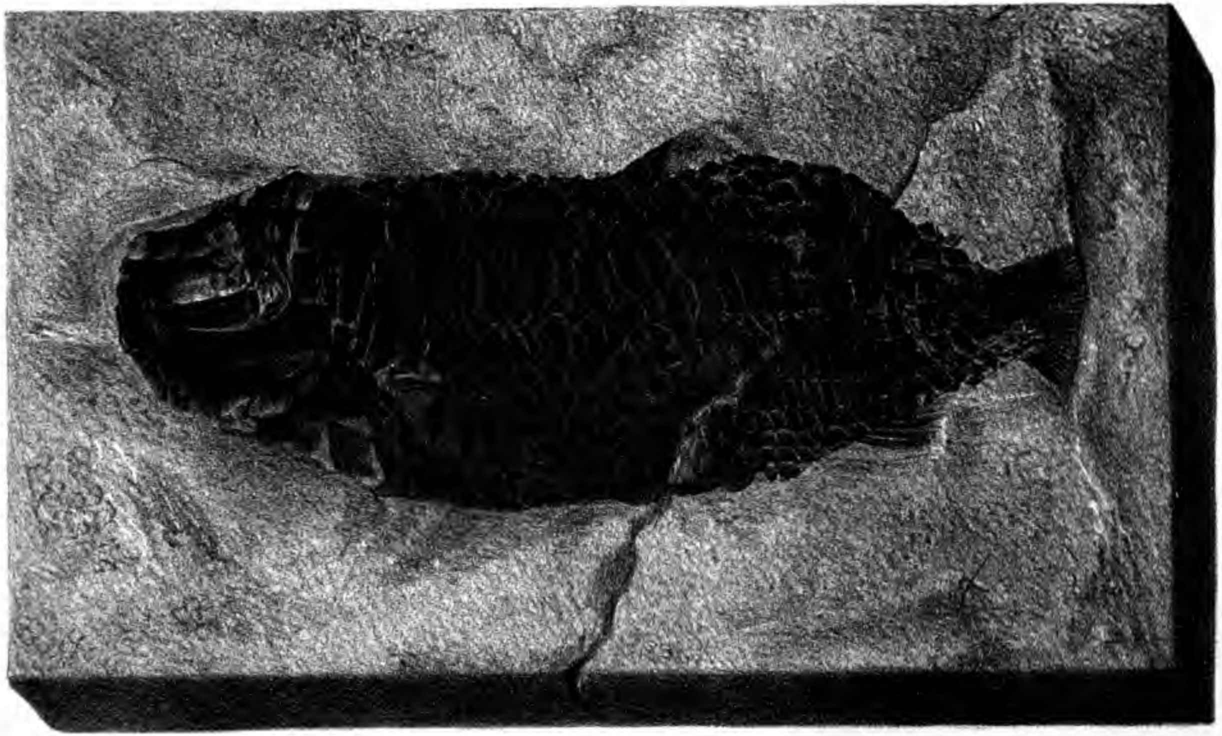

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PHOLIDOPHORUS PACHYSOMUS._ *Egerton.*

E. Forbes direx t

Day & Son, Lithrs to The Queen

BRITISH FOSSILS.

DECADE VI. PLATE V.

PHOLIDOPHORUS CRENULATUS.

[Genus PHOLIDOPHORUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2d Group. Body elongated, more or less fusiform.) Dorsal fin small, opposite the ventrals; caudal fin forked; the lobes equal; the base of the upper lobe invested with scales; teeth villiform.*]

SYNONYM.—*Pholidophorus crenulatus*, EGERTON, Proceedings of Geol. Soc. 1843, p. 184.

Description.—This is a rare but well-marked species of *Pholidophorus* belonging to the group of which *Pholidophorus Bechei* may be considered the type. In form and proportions it resembles *Pholidophorus latiusculus*, but the characters of the scales are wholly dissimilar. Of the *Pholidophori* of the lias, described by Agassiz, one only, namely *P. limbatus*, has serrated scales. This structure obtains also in *Pholidophorus crenulatus*, under description, but it is the only feature common to the two species. The head is either crushed or wanting in the only specimens I have seen. It seems to have been smaller in proportion to the entire length of the fish than in *P. Bechei*, *P. onychius*, and *P. limbatus*. The coracoid bone is traversed obliquely along its anterior curvature with rounded plaits. The pectoral fins are large, composed of about 22 rays, slender, and dichotomous in their distal portions. The anal fin is small. The caudal fin contains from 28 to 30 rays, with short articulations. The lower lobe is considerably larger than the upper one. The base of the upper lobe is invested with scales, and its upper margin protected by a series of strong imbricated fulcral scales; these increase in length as they succeed each other, until they almost rival the true marginal rays of the lower lobe. The scales present two very distinctive characters. The anterior portion or base of the scale is marked by a series of parallel, vertical ridges, extending backwards as far as the articulating process. These are covered by the antecedent scales, and mark the periodical increment. I have failed to find these evidences retained in any other species of this genus, although they are permanent in *Palæoniscus*, and some other genera. The exposed portions of the scales are traversed by alternate longitudinal plaits and striations, radiating at various angles, and increasing in size as they approach the free margins of the scales. These are slightly thickened, and distinctly serrated. The number of teeth carried by each scale is dependent on the number of striæ, and these decrease in the more distant parts of the body. The ventral scales are characterized by the coarseness of the cusps, and the paucity of the striæ. The dorsal and ventral fins are as yet unknown; judging from the fragments preserved in the specimens figured, they probably resembled these organs in the other species from the lias.

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* Poiss. Foss., vol. ii. p. 9.

History.—The specimens from which the description is taken are in my own cabinet.

Locality.—Lias of Lyme Regis.

EXPLANATION OF PLATE.

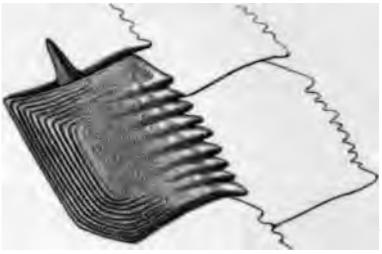
Fig. 1. The fish, natural size.
Fig. 2. Same (young).
Fig. 3. Scales, magnified.

P. DE M. GREY EGERTON.

Geological Survey of the United Kingdom.

PHOLIDOPHORUS
(Oolitic.)

3



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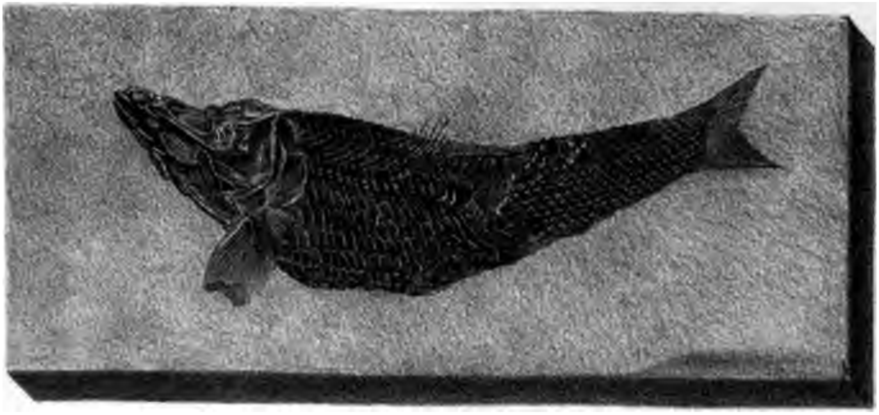

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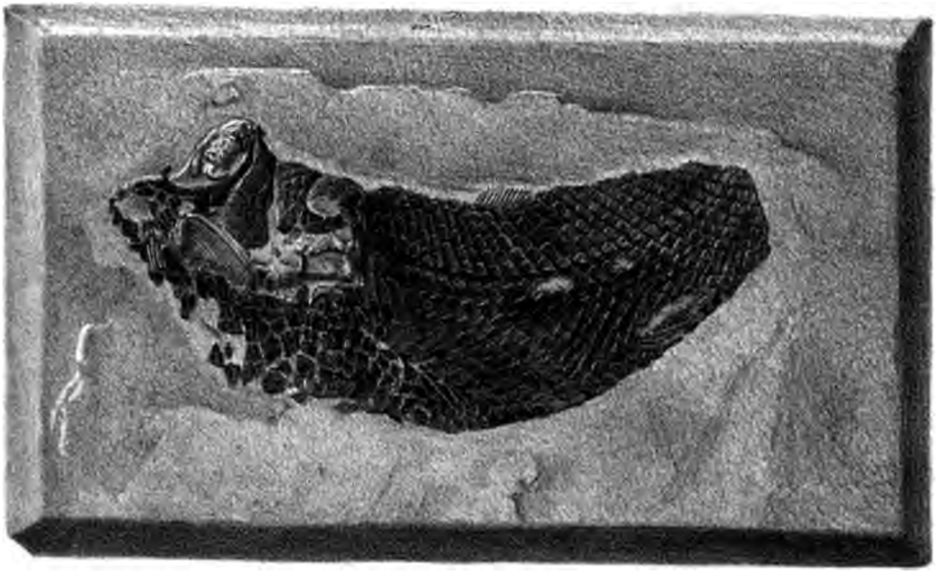

PHOLIDOPHORUS CRENULATUS. *Egerton*.

Jos [illegible] E. Forbes, Direx.t [illegible]

BRITISH FOSSILS.

DECADE VI. PLATE VI.

OPHIOPSIS BREVICEPS.

[Genus OPHIOPSIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2d Group. Body elongated, more or less fusiform.) Scales uniform in size; caudal fin slightly forked, the upper lobe invested with scales on the superior margin; pectoral fins long and large; dorsal fin much elongated, and slightly raised; ventral fins opposite the centre of the dorsal fin; head small; opercular apparatus strong and broad.]*

***Ophiopsis breviceps*, EGERTON.**

Generic Description.—The genus *Ophiopsis*, as originally defined by Agassiz (Poissons Fossiles, vol. ii. p. 289), was limited to a small number of fishes characterized by an extended dorsal fin, smooth, uniform scales, and a prolonged upper lobe of the dorsal fin. Subsequently, as we find in the "Additions et corrections," vol. ii. part 2, p. 289, a fish named *Ophiopsis Münsteri* was admitted into the genus, having serrated scales and other features approximating it to the *Pholidophori.* In consequence of this extension of the generic attributes, the boundary line between *Ophiopsis* and *Pholidophorus* becomes very indistinct; for, while on the one hand we have the elongated form and extended dorsal fin of the typical *Ophiopsis procerus* occurring in *Pholidophorus Flesheri*, on the other we have the small head and serrated scales characteristic of several species of *Pholidophorus*, cited as distinctive features of *Ophiopsis Münsteri.* We find also the uniformity of scales and unequal tail of *Ophiopsis* represented in *Pholidophorus latimanus, tenuiserratus, longiserratus*, and other species of the Oolitic epoch. This is not a fitting opportunity for entering on the general question of the propriety of rearranging the various forms now included in the genus *Pholidophorus;* as bearing, however, on the subject of the present article, I may hazard the opinion that if any reliance is to be placed on the generic characters assigned by Agassiz to *Ophiopsis*, it must be on the distinctive features of the dorsal fin; and if so, all the *Pholidophori* having extended dorsal fins must be removed from the latter to the former genus. In tracing the gradation from the narrow elongated form of the typical *Ophiopsides* to the shorter and thicker proportions of the *Pholidophori*, the little fish described in the following paragraphs, occupies the extreme limit between the two genera ; the transitional form of *Ophiopsis penicillatus* completing the series of that genus. It must, nevertheless, be considered a true *Ophiopsis*, since the characters of the dorsal fin and vertebral column are in strict accordance with that genus, and are of greater value than the more trivial features in which it resembles some species of *Pholidophorus*.

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* Agassiz, Poiss. Foss., vol. ii. part 2, p. 289.

Description.—*Ophiopsis breviceps* is a small fusiform fish, measuring 4 inches in length by 1 in depth. The head occupies only one fourth of the entire length. The vertebral column extends in a direct line from the head to the commencement of the caudal fin, without any curvature in the thoracic and abdominal regions. The bones of the head and gill-covers are ornamented with a pattern rather coarser than is usual in so small a fish. The mouth is large, and well furnished with small, conical, sharp teeth. The pectoral fins resemble those of the *Pholidophori*. The ventral and anal fins are small, and approximate to each other. The dorsal fin commences in advance of the ventral fins, and extends beyond the insertion of the anal fin. It contains nearly forty rays. The upper lobe of the tail is larger than the lower one, and is invested with scales for some distance, giving a heterocerque character to the organ. The scales are small and rhomboidal. The upper margins are concave, the lower ones convex. The enamel appears thicker on the margins of the scales, causing a slight depression of the central area. The posterior edges are strongly serrated over the whole body.

Affinities.—The generic affinities have been already alluded to. The species is very distinct from all with which I am acquainted.

Locality.—Lowest beds of the Lower Purbecks in Wockly, or Oakleigh quarry, near Tisbury.

History.—The figures and description are taken from the specimens in the collection of the Museum of Practical Geology, the only ones I have seen of this species.

EXPLANATION OF PLATE.

Fig. 1. 2. The fish, natural size.
Fig. 3. Scale, magnified.
Fig. 4. Tail of a larger individual.*

P. DE M. GREY EGERTON.

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* This may be *Ophiopsis penicillatus.*—Agassiz, Poiss. Foss., vol. ii. p. 290.

only 2 inches from the commencement of the tail. This backward position of the dorsal fin is a feature found in all the *Aspidorhynchi*, but in the species under description it obtains its maximum eccentricity. The scales are for the most part exposed on their under-surface. The principal series, or that traversing the middle of the flank, is composed of scales about half an inch in depth. This is succeeded above and below by several series of much smaller dimensions. The substance of all the scales is thinner than in any of the oolitic species, and the articulating rib on the inner face is less prominent. The outer surface of the scales, with the exception of those along the back of the fish, is smooth and devoid of ornament. The dorsal series, however, is characterised by strongly marked crests of enamel, arranged in continuous lines in the longitudinal direction of the scales. These ridges are most prominent in front of the dorsal fin. The tail is slender and deeply forked, forming an appropriate finish to the graceful outlines of this, one of the most elegant denizens of the waters in which it lived.

Locality.—The Dorchester Museum possesses two specimens of this rare fish, procured by Mr. Wilcox, of Swanage, from the quarries of Purbeck stone in that vicinity. I have named it in compliment to the Rev. Osmund Fisher, owing to whose exertions the town of Dorchester is in possession of a very thriving museum, and through whose kindness I have had the opportunity of examining all the valuable materials in that depository.

EXPLANATION OF PLATE.

Fig. 1. **Aspidorhynchus Fisheri, size of nature.**
Fig. 2. **Dorsal scales, magnified.**

P. DE M. GREY EGERTON.

June 1853.

BRITISH FOSSILS.

DECADE VI. PLATE VII.

PTYCHOLEPIS MINOR.

[Genus PTYCHOLEPIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Scales thick, elongated, plicated transversely on the base, and deeply furrowed longitudinally on the enamel; under surface smooth, and devoid of rib; pectoral fins pointed; dorsal fin opposite the ventral fins; anal fin remote.]

Ptycholepis minor, EGERTON.

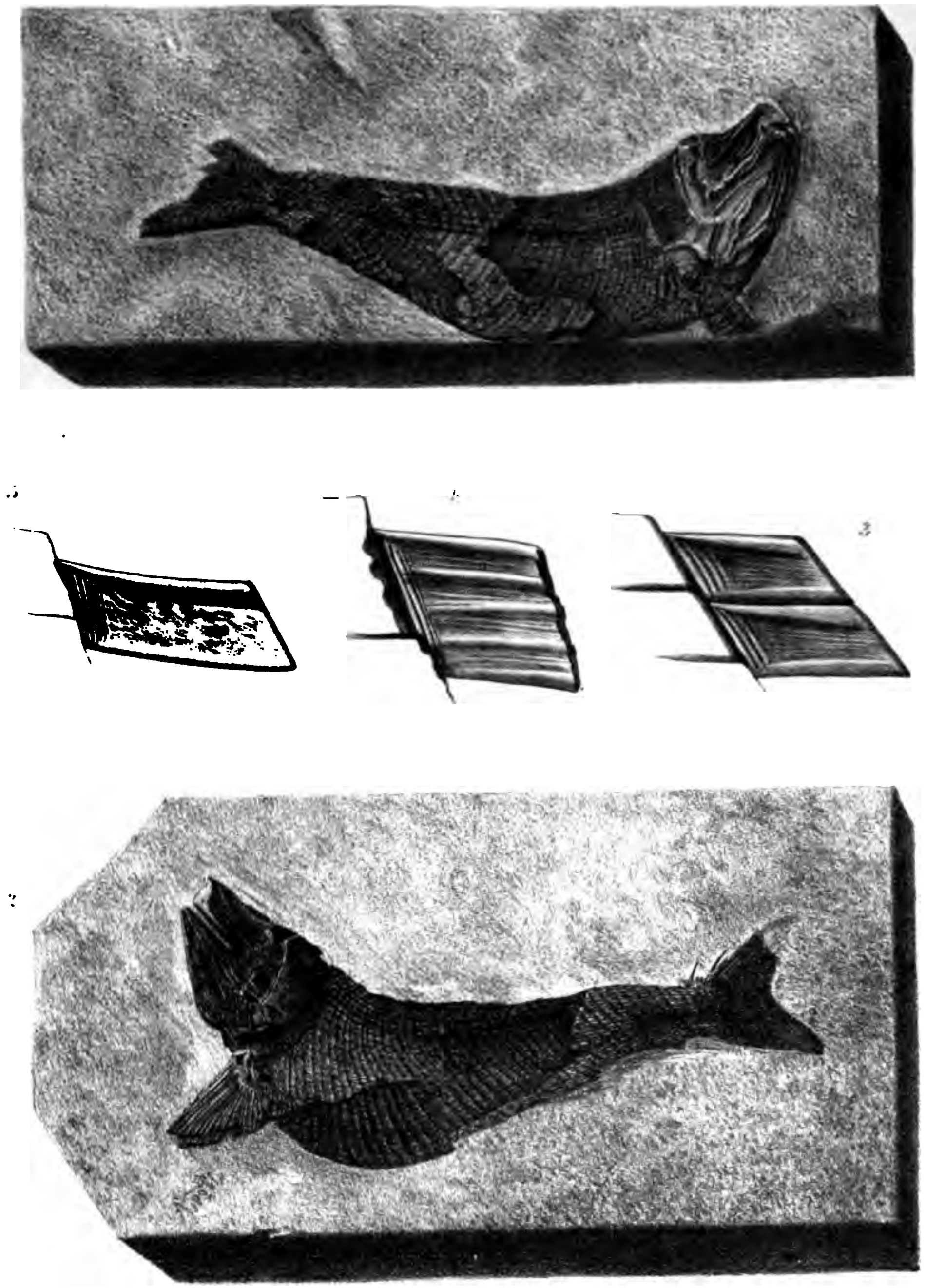
Description.—The genus *Ptycholepis* has hitherto been restricted to a single species, *Ptycholepis Bollensis*, remarkable for its occurrence in several widely-separated localities, viz., Whitby in Yorkshire, Lyme Regis in Dorsetshire, and Ohmden, in the kingdom of Wurtemburg. Being in possession of a fine series of specimens from each locality, I am enabled to amend the generic characters formed by Agassiz on imperfect materials. The pectoral fins when perfect are pointed rather than rounded at their extremities, and of moderate size. The dorsal fin is more remote than Agassiz imagined, being situate nearly as far back as in *Eugnathus*, and the anal fin is nearer to the tail than to the ventral fins. A very distinct character obtains in the under surface of the scales, not found in *Eugnathus*, or the allied genera. In these a projecting rib occurs, traversing the middle of each scale, produced to a point at the upper margin, and recessed at the lower, for the reception of the corresponding process of the adjoining scales; but in *Ptycholepis* the under surface is level, and the articulation is effected by an angular process of the upper margin of the scale, adapted to a notch in the lower margin of the succeeding scale. The specimen under description belongs undoubtedly to this genus, although the small size of the fish and its general outline recal at first sight the features of a *Pholidophorus*. The total length of the fish, including the tail, is 4 inches, of which the head occupies one fourth part; the greatest depth is 10 lines; this point occurs immediately behind the gill-covers, from whence the body diminishes gradually to the base of the tail. The bones of the head are marked with irregular, projecting lines at distant intervals, interspered with small isolated tubercles. The opercular bones are similarly ornamented, but the intervals between the lines are rather larger. A few scales immediately behind the scapular arch, on the central part of the body, are of large size. These are traversed by five or six longitudinal sinuous furrows, and terminate with a serrated margin. They are succeeded by scales more elongated, and having fewer and more regular furrows, and these on the dorsal, ventral, and anal regions give place to the narrow elongated scales (fig. 5.) peculiar to this genus. All the scales have their bases,—or those parts overlapped by the antecedent scales,—marked by parallel, transverse plicæ, showing the periods of growth. In this character they resemble the scales of *Pholidophorus crenulatus*, and some *Palæonisci*. The pectoral fin is broad at the base, and pointed at the termination. It is composed of about 30 rays. The transverse articulations of the rays are frequent near the base, but very distant in the other portions of the fin. The dorsal, ventral, and anal fins are wanting. The tail is small and elegantly forked. The articulations of the rays are more numerous in the lower than in the upper lobe, but the intervals between them become greater as they recede from the base. In these respects this organ has considerable resemblance to the caudal fin of *Pholidophorus*. The endo-skeleton in this genus was probably entirely cartilaginous, since I have been unable to discover in any specimen the least trace or impression of the spinal column or its appurtenances.

Affinities.—The genus *Ptycholepis* is considered by Agassiz to be most nearly allied to *Eugnathus*. This opinion is founded upon the characters of the scales and teeth. The latter I have not been able to detect in my specimens. In other respects it has considerable resemblance to the *Pholidophori*, and especially to some of the narrow-scaled species of that genus, which I have proposed to remove to the new genus *Histionotus*. These features, together with the absence of a bony endo-skeleton, which is of considerable solidity in *Eugnathus*, lead me to infer that the *Ptycholepides* were altogether more feeble and less predatory than the *Sauroid* genera, with which they are allied.

Locality.—The specimen above described was found in the lias quarries at Barrow-on-Soar, and is the only example of this species I have met with. The two halves are in the possession of Lord Enniskillen and myself.

Geological Survey of the United Kingdom.

PTYCHOLEP
Oolitic



PTYCHOLEPIS MINOR *Egerton.*

EXPLANATION OF PLATE.

Fig. 1. Fish, natural size.
Fig. 2. Counterpart of same.
Fig. 3. Scales from the flank.
Fig. 4. Scale near the scapular arch.
Fig. 5. Scale near the tail.

P. DE M. GREY EGERTON.

BRITISH FOSSILS.

DECADE VI. PLATE VIII.

LEPTOLEPIS MACROPTHALMUS.

[Genus LEPTOLEPIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Scales very thin and rounded; dorsal fin opposed to the ventrals; operculum broad; sub-operculum large; teeth villiform; lower maxillaries with strong coronoid processes.]

SYNONYM.—*Leptolepis macropthalmus*, EGERTON, Journal of Geol. Soc., vol. i. p. 231.

Generic Description.—In the year 1844, I communicated to the Geological Society a brief account of this and some other fossil fishes then recently discovered in the Oxford clay, at Christian Malford; but as no figure of this species is given in the Journal of that Society, and as I have since had the advantage of examining a larger number of specimens from the same locality, disclosing additional characters, I have thought it an appropriate subject for this decade. Before commencing the description of the species, I must allude to some anatomical details common to the genus, which have induced me to make some alterations in the generic characters assigned to it by Agassiz. He describes (Poiss. Foss., vol. ii. p. 13.) the teeth to be "en brosse, en avant des mâchoires; de plus grosses dans leur partie postérieure;" and at part 2, p. 129, "Ils ont des mâchoires armées de dents coniques, absolument comme les Sauroïdes." After a careful examination of more than 100 specimens in my own cabinet, I have entirely failed to detect any trace of the conical teeth alluded to in the foregoing quotation. I am, consequently, inclined to believe that the teeth in this genus were exceedingly minute, so much so as to have perished in most cases with the integumentary investment of the jaws. The only allusion to the teeth in the specific descriptions of the *Leptolepides* in the "Poiss. Foss." is to this effect: "Les dents ne sont visibles qu'à la mâchoire inferieure; mais elles sont si petites, que ce sont presque des dents en brosse." This entirely coincides with the result of my own examination, and is, I think, corroborated by the general form of the mouth, which I now proceed to describe. This organ is entirely bounded by the premaxillary (figs. 1, 2, *b.*) and lower maxillary bones. The former are very long, reaching, when the mouth is shut, as far back as the orbit; they are scimitar-shaped, the curve being backwards and upwards. The lower maxillaries are remarkable for having, at one third distance from the symphisis, a strong ascending coronoid process (figs. 1, 2, 3, *a.*) expanded at its upper extremity, and rising nearly at right angles from the dentary bone. In front of this process the bone is thickened out into a table, corresponding with a similar thickening of the proximal ends of the premaxillaries, and well adapted for the support of a cushion of minute villiform teeth. When the mouth is slightly open, the gape is defined by the anterior part of the premaxillaries, and that portion of the lower maxillary in advance of the coronoid process, and is nearly vertical; but when fully expanded the long premaxillary bones sweep forwards as far as the symphisis of the lower jaw, carrying with them a broad fold of integument, and forming a cavity nearly equal to the diameter of the entire head. The great length of the lower jaw behind the coronoid process provides the means for this enormous expansion of the oral orifice. This singular conformation of the lower jaw occurs in the *Carps* and some of the allied *Cycloid* fishes of the present day. That Agassiz is correct in arranging *Leptolepis* in the *Sauroid* rather than the *Lepidoid* family, I have little doubt; for on comparing it with other genera, I find that the allied genus *Thrissops* has also a coronoid process, though of smaller dimensions, with distinct *Sauroid* teeth, while the genus *Pholidophorus*, which is liable to be confused with *Leptolepis*, has the lower jaw of a very distinct form.

Description.—This species of *Leptolepis* is the most slender and elegant of the genus; the head partakes of the graceful character of the general form, being narrow and elongated. Its component bones are thin and perfectly smooth, with the exception of the preoperculum, which is characterized by coarse striations, radiating from its anterior margin. The orbit is large, but not so large (compared with other species) as I conceived to be the case when I gave the name to the species. The spinal column contains about 40 vertebræ; the terminal ones decrease rapidly in size, and trend slightly upwards. The ribs and the other vertebral apophyses are slender. The pectoral fins contain about 12 rays. The ventral fins are situated nearly in the centre of the body, and are comparatively large, containing each from 10 to 12 rays. The dorsal fin is small, and is directly above the ventrals. The anal fin is also small, and placed about mid-way

Description.—Lord Enniskillen's specimen, the only one hitherto found, measures ten inches in length. The parts anterior to the eye socket and behind the termination of the anal fin are deficient. The depth is nearly uniform from the nape to the anal fin, being about two inches and a half. Behind the anal fin, the depth is one inch and a half. From the gradual convergence anteriorly of the outlines of the head, it is probable that the muzzle was elongated, after the fashion of an *Eugnathus* or *Sauropsis*. The gape was large, and both jaws were furnished with numerous sharp conical teeth. The branchiostegous rays are flattened, and apparently not so numerous as those of *Pachycormus*. Twelve are distinguishable, of which the middle ones are the broadest. The opercular flap is crescentic in form, and extends some distance behind the line of union of the vertebral column with the occiput. The preoperculum is strong and prominent, and is invested with a thick coat of ganoine, plicated longitudinally. The surface ornament of the operculum and sub-operculum is finer and more granular in its arrangement, and does not conceal the lines of successive growth running parallel to the free margin of the flap. The pectoral fin is broken off at a short distance from the base. It contains about twenty-six rays; these, as far as they are preserved, are single, without transverse sutures. The rays of all the other fins correspond in being compressed and imbricate. The ventral fin has a few short anterior rays, and about twenty principal ones. They are so closely crowded together, that it is impossible to distinguish the precise number. The rays of the dorsal fin are gracefully curved backwards; they are in number about twenty-four. The transverse joints are at distant intervals. The anal fin is remarkable for its extension towards the tail; it measures one inch and three quarters along the base, and probably contains between fifty and sixty rays. The squamation of *Thrissonotus* is very elegant, with regard both to the shape and beauty of the component parts, and the graceful arrangement of the dorso-ventral lines. The scales are all comparatively small, but vary much in relative size. The largest, as is generally the case, occur in the neighbourhood of the lateral line, and the smallest, on the abdominal region. The former are rhomboidal in form, the latter are long and narrow, resembling elongated parallelograms. The surface ornament is, for the most part, due to the permanence of the successive lines of growth: but, in the anterior part of the body, and especially in the vicinity of the nape, a few small vermicular probetween the ventral and caudal fins. The latter organ is symmetrical; it has eight rays in the upper lobe, springing from the terminal vertebra, and three or four marginal rays above. The lower lobe has from eight to ten rays. The scales are small and very thin, finely sculptured with delicate, concentric striæ on the enamelled surface. This species differs from the following in its more elongated proportions and the relative small size of the head, as well as in the form of the centrum of the vertebræ.

Affinities.—The generic relations of *Leptolepis* are with *Thrissops* and *Megalurus*. Professor Müller considers the recent *Amia* to be a living representative of this section of the *Ganoid* order, and proposes to group them as a family of his *Ganoidei holostei*. The affinities of the species have been alluded to in the description.

Locality and Geological Position.—This fish appears not uncommon in the Oxford clay, at Christian Malford, associated with several other species of fossil fish, and with the cephalopodal remains so remarkable for the rare conservation of their more perishable parts.

Explanation of Plate.

Fig. 1. Fish, the size of nature. *a.* coronoid process. *b.* premaxillary.
Fig. 2. Specimen with the mouth open. *a.* coronoid process. *b.* premaxillary.
Fig. 3. Specimen showing the under part of the head. *a. a.* coronoid processes.
Fig. 4. Scales, magnified.

P. de M. Grey Egerton.

BRITISH FOSSILS.

DECADE VI. PLATE IX.

LEPTOLEPIS CONSTRICTUS.

[Genus LEPTOLEPIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Scales very thin and rounded; dorsal fin opposite the ventrals; operculum broad; sub-operculum large; teeth villiform; lower maxillaries with strong coronoid processes.]

Leptolepis constrictus, EGERTON.

Description.—The genus *Leptolepis* contains no fishes of magnitude, nevertheless, as some of the species are very minute, the range of size is considerable. *Leptolepis constrictus* holds an intermediate position in this respect. The largest of four specimens, which I have examined, measures 3¼ inches from the extremity of the nose to the fork of the tail. The head is small, occupying less than one fourth of the entire length, and of elegant form. Indeed, the whole fish is remarkable for the graceful proportions it displays. The bones of the head are exceedingly thin, and quite smooth, with the exception of the preoperculum, which is characterized by a fan-like group of prominent ridges, radiating from the anterior angle of the bone. This structure distinguishes the species very neatly from *Leptolepis concentricus*,* which has the preoperculum as smooth as the other cranial bones. The mouth is small, and opens upwards. The lower jaws are curved. No teeth are visible in the specimens I have seen, which, in other respects, are in a good state of preservation. The coracoid bone is strong and rounded. The spinal column consists of 38 vertebræ. These are longer than broad, and are remarkable for the depth of the constriction of the centrum between the articulations. Hence the specific designation. This constriction gives to each vertebra the form of an hour-glass. The relative position, size, and character of the fins in this genus vary little. In the species under consideration they are all small, and the rays slender. The pectorals contain about 19 rays in each fin, the ventrals 10, and the dorsal and anal 12. The caudal fin is bifurcate, the lower lobe being rather larger than the upper. The scales are oval, and their surface marked by numerous fine concentric lines, as in all the other species of the genus.

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* Egerton, Journal of Geol. Soc., vol. v. p. 35.

Affinities.—This species is distinguished from *Leptolepis concentricus* by the sculptured preoperculum, the greater tenuity of the scales, and the smaller size of the head. It has some resemblance to *Leptolepis Knorri*, found at Solenhofen, but has the head proportionately larger, the apophyses of the caudal vertebræ less inclined, and the form of the vertebræ very distinct. I have a specimen of *Leptolepis*, found in a liassic bed near Curcy in France, which very much resembles this species.

Locality.—All the specimens I have seen of this species belong to Mr. Moore, and were found by him in a bed of light-coloured lias near Ilminster.

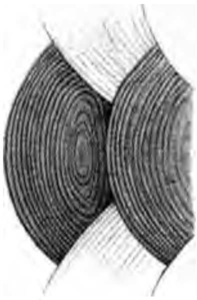
EXPLANATION OF PLATE.

Fig. 1. The fish, natural size.
Fig. 2. Another specimen.
Fig. 3. Scales, magnified.

P. DE M. GREY EGERTON.

LEPTOLEPIS.
(Oolite)

3



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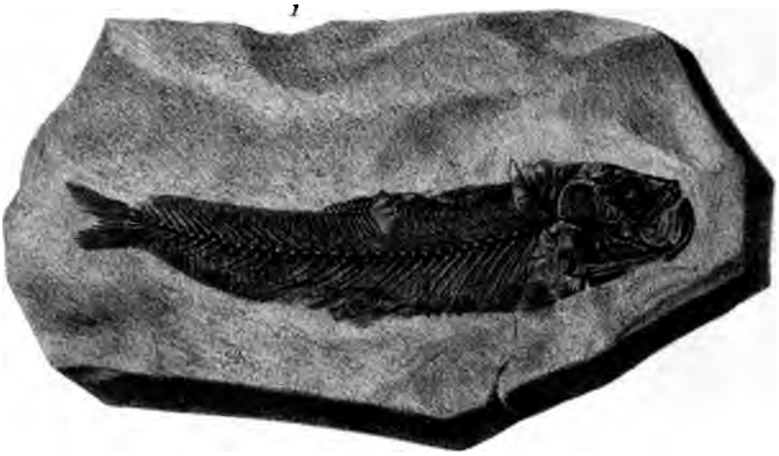

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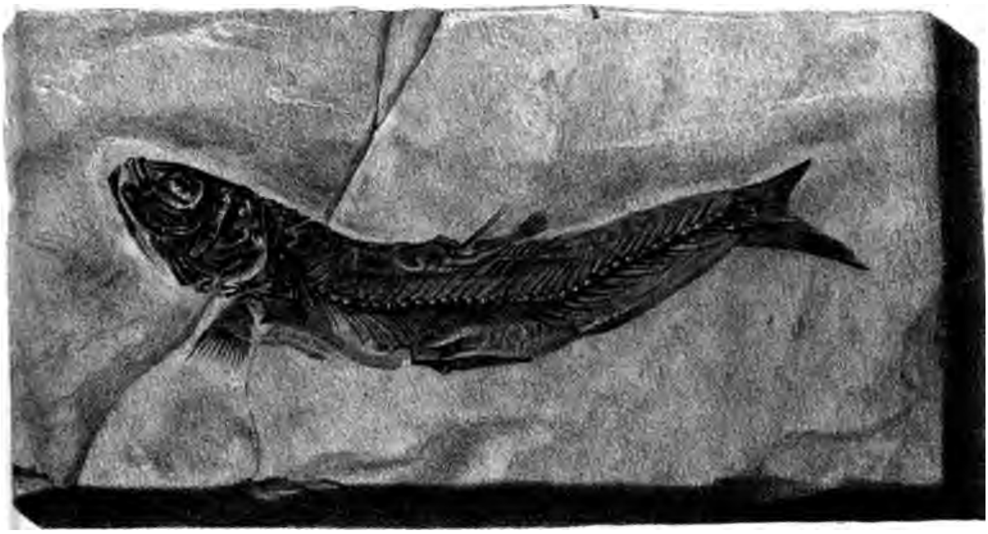

LEPTOLEPIS CONSTRICTUS _ *Egerton*

BRITISH FOSSILS.

DECADE VI. PLATES X., X*.

LOPHIOSTOMUS DIXONI.

[Genus LOPHIOSTOMUS (*λοφιος*, *lophius*, *στομα*, *os*). EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci.) Body short and thick; head depressed; mouth large, dehiscent; premaxillary and maxillarics with a single row of large, conical, incurved, grooved teeth; smaller teeth on the vomer and palatines; divided nasal; lower jaw deep, with an outer row of stronger and an inner row of weaker teeth; glossohyal expanded into a broad plate; scales rhomboidal, ganoid, pitted on the surface and serrated at the posterior margin.]

SPECIES UNICA.—*Lophiostomus Dixoni*, EGERTON.

Description.—In order to convey an adequate idea of this singular fish, it has been necessary to exceed the limits of illustration generally adopted in this publication. The two plates, from the masterly hand of Mr. Dinkel, contain four views of the specimen, together with magnified representations of the scales and teeth. The numbers used to designate the various bones are those employed by Professor Owen, in his writings on the homologies of the Vertebrate skeleton. It is not in this respect only that I am indebted to my distinguished friend; I have also to acknowledge the invaluable assistance he has afforded me in working out the details of this curious fossil, and his recognition of its affinities to the recent *Arapaima*. In form this fish was short, squat, and bulky, contrasting remarkably in these respects with the more or less elongated features of the abdominal predatory fishes, both recent and fossil, and recalling rather the similitude of a *Siluroid*. The head is wide and flattened, and measured probably more than a fourth of the entire length. The muzzle is broad and semicircular, projecting somewhat beyond the lower jaw; the gill-covers are large, and the branchiostegous rays of great strength. All these bones are invested with a dense layer of ganoine, having the surface raised into innumerable small prominences more or less confluent or distinct, resembling in this respect some recent *Siluroids* and fossil *Ganoids*. The frontal bones (Plate x*, fig. 11) form a large, somewhat triangular plate, expanded towards the occiput, and bearing two remarkable prominences behind the orbits. Behind and beneath this projection, on the right side, is seen a strong process extending downwards and backwards (fig. 8). This, from its form and position, must be the mastoid bone; although, from the obliteration of all sutures, it is impossible to determine whether it is not partially composed of the postfrontal. Immediately in advance of the frontal bones are two small semilunar bones (fig. 15) corresponding to two semicircular emarginations of the anterior edge of the frontal plate, and two recessed facets of the premaxillary bone (fig. 22). With respect to these bones, Professor Owen writes as follows:—"I am now satisfied, from the way in which the bones or divided bone fit into the emarginations of the frontal, that they are the nasals, answering to the similarly divided but more elongated nasal of *Lepidosteus*." In following up this view the correctness of the identification becomes evident on examining the corresponding parts in the genera *Polypterus* and *Amia*, where we find the long narrow nasals of *Lepidosteus* represented by bones very similar in form to those of the fossil under consideration. External to these bones are two small ossicles (fig. 19), occupying the position of the "nasaux" of Cuvier. These are the turbinals of Owen, and correspond closely with these bones in the recent *Amia calva*. Several fragments of bone (fig. 73) occur between the turbinals and the upper maxillary, apparently belonging to a large lachrymal or suborbital bone. Immediately behind the upper portion of this bone a recess in the frontal bone marks the position of the orbit, and attests the absence of the supraorbitals which surround the orbit in *Lepidosteus*. The area of exposed chalk between the orbit and the preoperculum may have been occupied by a large postorbital plate, as in *Arapaima* and *Amia*. The upper jaw is composed of a single cuneiform premaxillary and of large arcuate maxillary bones, as in *Arapaima* (Plates x., x*, figs. 21, 22). Each of these components supports a single row of long, sharp, conical teeth, very regular in size, incurved at the points, and fluted on the surface. Within there is a second row of similar teeth, but rather smaller in size; the central ones are situate on the vomer (Plate x., fig. 13), and the lateral ones on the palatine bones (Plate x., fig. 20). The lower jaw is composed of long and broad dentary bones (Plates x., x*, fig. 32), with small articular ossicles (fig. 30) at the condyloid extremities. The teeth are of like character with those of the upper jaw, and equally regular, but they are implanted in a double row; those constituting the outer row being considerably larger than the secondary ones. The operculum (Plate x*, fig. 35) is of moderate size and of triangular form, narrow above and broad below, as in *Lepidosteus*. The suboperculum (fig. 36) is long and narrow, and joins the operculum on a horizonal line. In front of this the remains of a small inter-operculum occur (fig. 37). The opercular apparatus is completed by a moderately-sized slightly curved preoperculum (fig. 34). This bone corresponds with the other bones of the head in superficial character, and is not, as is frequently the case, distinguished by a more bold and radiating style of ornamentation. The hyoidean arch is characterised by the great strength and expanse of its component parts. The ceratohyal bone (Plates x., x*, fig. 40) is flat and curved, and expands below into a broad spatula. It supports a series of 10 or 12 short falciform branchiostegals (fig. 44), the lower ones being shorter and broader than those which precede them. They partake of the enamelloid character common to all the other bones of the head. The most remarkable feature in the anatomical structure of this region, is to be found in the disproportionate development of the glossohyal or lingual bone, which is here expanded into a broad, oval disc, measuring 1½ inch in length by 1 inch in width (Plate x., fig. 42), and occupying the entire space beneath the rami of the lower jaw when the mouth was closed. The position of the broad articular extremities of the ceratohyals, with reference to this plate, leads to the inference that it derived its support from these bones without the intervention of the basihyals. It is, however, very possible that the latter may either be confluent with the ceratohyals, as in the conger eel, or may support the base of the glossohyal plate. The scapular arch is for the most part concealed, but enough remains to show that it partook of the massive proportions of the adjoining parts. The scapula (Plate x*, fig. 51) is short and of great width, being flattened out into the resemblance of an operculum. It is smooth on the surface, a feature peculiar to this bone. The suprascapula (fig. 50) is smaller than the scapula, and of more slender proportions. The lower extremities of a pair of strong coracoid bones are seen in Plate x., fig. 52. The pectoral fin is unfortunately mutilated; enough, however, remains to indicate an organ of singular aspect and powerful proportions. It contained 10 or 11 rays of great strength, diminishing in size from first to last. They are invested with a dense coat of ganoine, composed of rugged imbricate tubercles, similar to those on the bones of the head, but much coarser; the rays are very close set, and are of like character; the first, although the largest, not exhibiting any distinctive features, such as are frequently found in some recent families. The appearance in the plate of a series of carpal bones is deceptive, and is due to a fracture of the base of the fin and the removal of the outer surface of the rays. The ventral fins are abdominal, and situated very near the pectorals. They are comparatively small, containing four rays of similar appearance to the pectoral rays, but of slighter form. They are supported upon two pubic bones, of which the distal extremities only are preserved (Plate x., fig. 63.) The scales constitute a peculiar and valuable feature in considering the affinities of this fish, a subject which will be treated in the sequel. The dorsal and lateral series are for the most part absent, and the few that remain are inverted; the ventral scales, however, are in perfect state of preservation. They are quadrilateral, and more or less acutely rhomboidal, as in *Lepidosteus* and most of the fossil *Ganoids*. They have a thick superficial layer of dense, lustrous ganoine, deeply and irregularly pitted and grooved on the surface, and terminate posteriorly in an uneven and coarsely serrated margin. The upper anterior corner of the root of the scale is produced to an acute angle, while the lower corner is rounded off to fit the corresponding angle of the succeeding scale. This compact adaptation of the adjoining scales to each other is still further secured by an articulating process on the upper margin of each scale lodging in a corresponding depression in the lower margin of the next in the series. This arrangement is identical with that in many of the genera of the fossil *Ganoids*, and obtains also in the recent *Lepidosteus*. It is much to be regretted that no other portions of this fish have been preserved, since the position, form, and structure of the dorsal and caudal fins, and the character of the vertebral column are most important elements in determining its true character in relation to the other members of the class to which it belongs.

Affinities.—The generic title I have adopted for this fish has no reference to any real or supposed affinities with *Lophius;* it has been suggested solely by the disproportionate size of the mouth, so remarkable in both. In general features *Lophiostomus* is so unlike any fish, either fossil or recent, with which I have been able to compare it, that it must for the present be considered an isolated form. It possesses, nevertheless, some resemblances in structural details, both to fossil and recent forms, which point to an approximation of its true position in the scale of nature. With respect to the order to which this singular fish should be referred, there is fortunately no doubt. Thanks to the labours of the talented author of the Agassizian system, a single scale is decisive of its being a true *Ganoid.* Again, the association of the rhomboidal scale, with large predatory teeth, stamps it a member of the *Sauroid* family. As compared with other fossil members of this family, it approximates *Eugnathus* in the character of the scales, but differs from this genus and resembles *Caturus* in the uniformity of the teeth. Before I was cognizant of the scales, I was inclined to think it might belong to the *Cœlacanths*. The bulky form and depressed head, the broad lower jaw, fluted teeth, and sculptured bones, are all features prevalent in that family ; but the angular scales forbid this association, as the boundaries of these families are now defined. There are certainly exceptional forms among the fossil *Sauroids*, such as *Megalurus* and *Leptolepis*, with rounded scales, but these are combined with other characters preponderating in favour of the *Sauroid* relationship. On comparing *Lophiostomus* with recent fishes, the most striking features which naturally suggest themselves are the dentigerous maxillaries, the divided nasal, and the expanded lingual bone. The first peculiarity, namely, the part performed by the maxillary bone in the conformation of the upper jaw, is common to the *Clupeidæ*, the *Salmonidæ*, to *Lepidosteus*, and *Polypterus*, and to several genera of doubtful position, such as *Arapaima*,* *Amia*, *Hyodon*, *Megalops*, *Erythrinus*, *Macrodon*, &c. Most of these genera have also teeth on the vomer and palatine bones. The divided nasal is a structure of more limited occurrence. It obtains in *Lepidosteus*, *Polypterus*, *Amia*, *Arapaima*, *Heterotis*, *Erythrinus*, as also in *Megalichthys*, and some other fossil genera. The lingual, or submaxillary plate, the glossohyal of Pofessor Owen, occurs in *Elops*, *Megalops*, and *Amia*, but attains its maximum development in *Arapaima*. Among fossil genera, *Asterolepis* has this bone single ; in *Holoptychius* and some of the *Dipterians* it is double as in *Polypterus*, while in *Megalichthys* and *Osteolepis* it is replaced by three plates. The combination of these features most in accordance with those in *Lophiostomus* occurs in the genera *Arapaima* and *Amia*. In reference to the former, Professor Owen wrote to me from Paris last autumn as follows : " Having your chalk fish still in view, I looked sharp at all the fishes' skulls at the Garden of Plants, and found almost its fac-simile in that of the great *Sudis* (Arapaima) *gigas* ;—the same short premaxillaries, long dentigerous maxillaries, rear rank of shorter teeth on the vomer and palatines, divided nasal, broad glossohyal, numerous branchiostegals, and rough outer surface of the bone, &c. ; the general shape much closer to the fish from Alfriston than the skull of *Lepidosteus* is, but clearly showing the same *Sauroid* or *Salamandroid* family construction." In some respects the resemblance to *Amia* is also very remarkable, especially in the form and proportions of the divided nasal, and the turbinal bones, in the position of the orbit, the shortened antero-posterior dimensions of the cranium, the larger size of the teeth, and the absence of the deep pits characteristic of the head bones in *Arapaima*. The flattened head resembles that of *Polypterus*, and the scales and operculum those of *Lepidosteus*.

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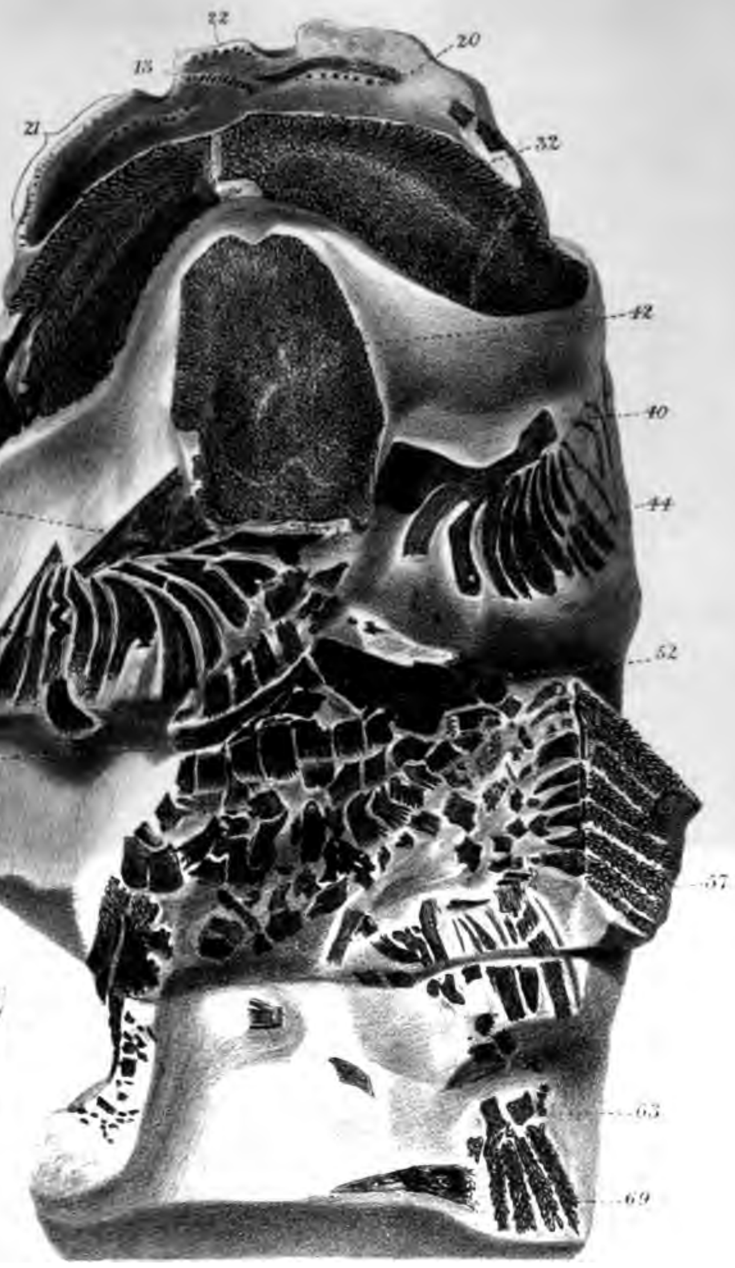
* *Vastres*, Cuvier and Valenciennes.

To recapitulate the peculiarities of *Lophiostomus*: it has the scales of a *Ganoid*, and the teeth of a *Sauroid*, associated with characters found in *Arapaima* and *Amia*, but differing from all these in outward form and proportions, and in these respects approximating rather to the family of the *Cœlacanths*. It would be premature to attempt, from a single specimen, and that an imperfect one, to unsettle established generalizations, without sufficient materials to prepare a sound basis of re-adjustment. It is, however, clear that when the period arrives for a re-classification of many genera, both recent and fossil, now occupying somewhat doubtful positions, the subject of this description must form an essential element in the consideration. Cuvier has placed *Lepidosteus* and *Polypterus*, *Amia* and *Arapaima*, with the *Clupeidæ*; Agassiz considers the two former as *Sauroids*, the two latter, *Cœlacanths*; while Müller places *Arapaima* with the *Clupeidæ*, and creates a new order, *Ganoidei holostei*, for the families *Lepidosteini* and *Polypterini*, and suggests a third family for the reception of *Amia*, combined with the fossil genera, *Megalurus*, *Leptolepis*, *Thrissops*, and their allies. This is not the place to enter upon a discussion of the many points raised in such a controversy, but we must hope that before long Professor Agassiz, who is now so opportunely located for studying some recent forms implicated in the question, may be able to effect a satisfactory settlement of these disputed points.

History and Geological Position.—The only specimen I have seen of this fish is in the British Museum. It was found in a chalk quarry near Alfriston, in Sussex, and was presented to the National Collection by Captain Beckford, R.N., of Ryde. I am indebted to my friend, Dr. Mantell, for the drawings of the specimen, made some years ago by Mr. Dinkel; and, in accordance with his wishes, I have named the species after the late Mr. Dixon, a tribute I am too happy to make to the memory of one whose friendship I long enjoyed.



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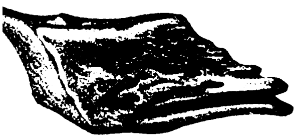

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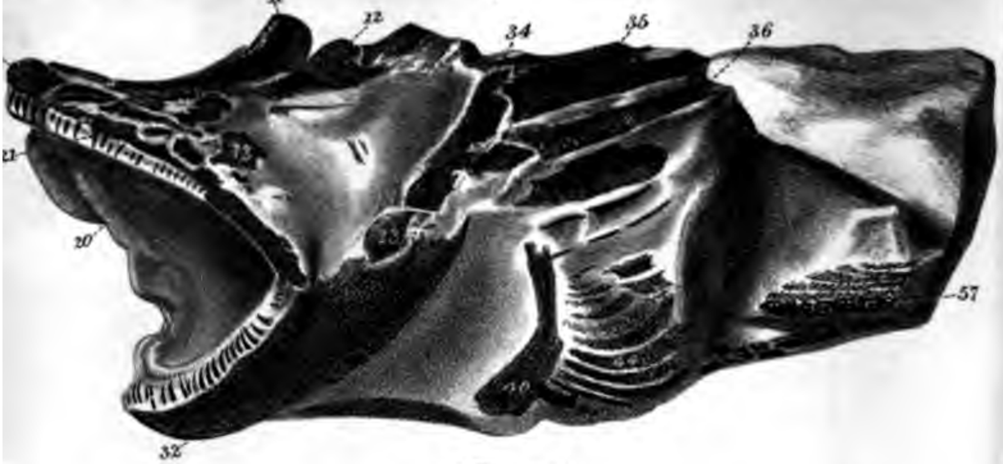
LOPHIOSTOMUS. DIXONI. *Egerton*

1



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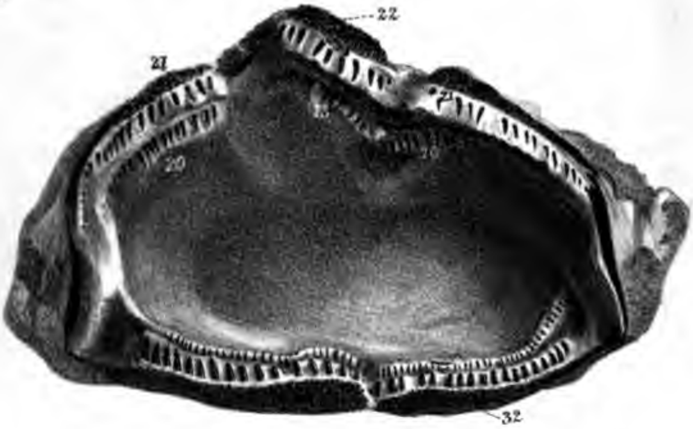

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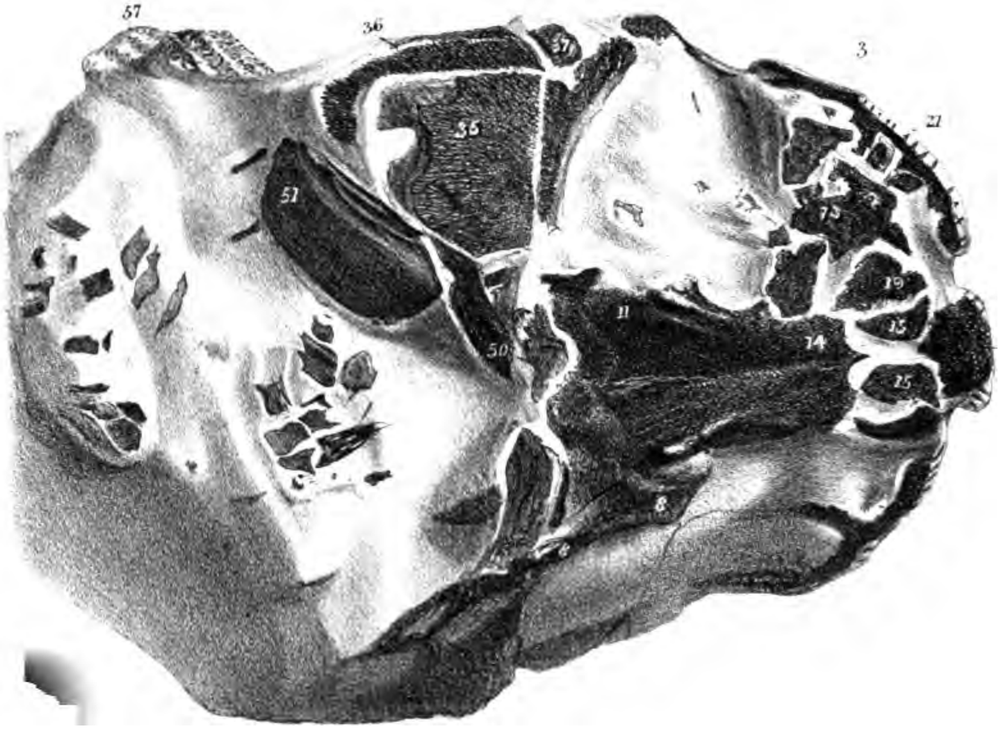

TOMUS DIXONI Egerton

EXPLANATION OF PLATES.

PLATE X.

Fig. 1. Lophiostomus Dixoni, under view.
Figs. 2. 3. Teeth, magnified.
Figs. 4. 5. Upper surface of scales.
Fig. 6. Under view of scale.

PLATE X*.

Fig. 1. Lophiostomus Dixoni, side view.
Fig. 2. Ditto ditto front view.
Fig. 3. Ditto ditto upper view.

REFERENCE TO FIGURES.

8. Mastoid bone.
11. Frontal.
12. Postfrontal.
13. Vomer.
14. Prefrontal.
15. Nasal.
19. Turbinal.
20. Palatine.
21. Maxillary.
22. Premaxillary.
23. Articular.
32. Dentary.
34. Preopercular.
35. Opercular.
36. Subopercular.
37. Interopercular.
40. Ceratohyal.
41. Basihyal.
42. Glossohyal.
44. Branchiostegal.
50. Suprascapular.
51. Scapula.
52. Coracoid.
57. Phalanges.
63. Pubic.
69. Ventral fin.
73. Suborbitals.

P. DE M. GREY EGERTON.

MEMOIRS

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GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE VII.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

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BRITISH FOSSILS.

DECADE THE SEVENTH.

THIS Decade is devoted to figures and descriptions of Trilobites, a group of extinct Crustacea of the highest geological interest. These remarkable fossils are wholly restricted to Palæozoic formations. The progress of research has shown that the various genera and species of Trilobites are remarkably characteristic of well-defined geological horizons; consequently, the study and exact definition of them is laid much stress upon by the geologist whose labours are directed to the investigation of the more ancient rocks.

The recent publication of a beautiful work by M. Barrande, on the Trilobites of Bohemia, in which the species are fully illustrated and described, affords means of comparison with the specimens of British Trilobites (usually less perfectly preserved), such as we did not before possess. It will be seen from the following descriptions that but few of our species are identical with those of Bohemia, and thus we get at an interesting indication of a geographical distribution of these primæval animals.

Of forty-five species here described, but one, a *Phacops*,—a member of a different section from that previously illustrated, belongs to any genus as yet selected for these Decades.

Cheirurus is exemplified by a species heretofore known only in a fragmentary state.

Sphærexochus mirus is a cosmopolitan fossil, of which excellent specimens have been lent to us for illustration.

Encrinurus and *Acidaspis* are typified by new species from the lowest fossiliferous deposits.

Cyphaspis and *Æglina* are for the first time published in England; and a new genus, *Cyphoniscus*, is proposed for some minute and hitherto undescribed forms.

Remopleurides is republished, with some additional data for the correct account of its structure. It is proposed, for what appear to be cogent reasons, to refer some curious variations in closely allied forms to sexual differences.

Under the ten genera here illustrated, the descriptions of all known British species are given. They have in every instance been drawn up by Mr. Salter.

EDWARD FORBES.

August 1, 1853.

BRITISH FOSSILS.

DECADE VII. PLATE I.

PHACOPS DOWNINGIÆ.

[Genus PHACOPS. EMMRICH. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Head strongly trilobed; glabella lobed, and broadest in front; facial suture ending on the external margin; eyes largely facetted; hypostome oblong, rounded at the end; thorax of 11 segments, the pleuræ grooved and facetted for rolling up; tail strongly ribbed, of several segments, the margin entire or toothed.]

[Sub-genus *Acaste*. GOLDFUSS. Form convex, and contractile into a ball. Glabella not much inflated, all the lobes distinct; facial suture within the edge or marginal in front; head angles rounded or with short spines; hypostome obtuse, entire; body segments rounded at the ends; tail of a moderate number of distinct segments (11 or less), its edge without lateral spines.]

DIAGNOSIS. ***P. alutaceus; capite transverso, margini frontali angulato; glabellâ depressâ oblongâ subparallellâ, sulcis utrinque tribus distinctis, lobo basali lineari, secundo ovali, superiori transverso—sed margine superiore ascendente sinuato—lobis omnibus planis et fere ad medium glabellæ extensis, spatio angusto interjecto: lobo cervicali elevato; oculis magnis nec eminentibus: caudâ subtrigonâ, axi convexo costis quinque distinctis tribusque obscuris prædito,—lateribus quinque-costatis, costis duplicatis; margine distincto, apice angulato.***

SYNONYMS. *Calymene macrophthalma* (BRONGN.), BUCKLAND (1836), Bridgw. Treatise, pl. 46. fig. 5 (not 4.) *Calym.? Downingiæ*, MURCHISON, Silur. Syst. (1839), pl. 14. fig. 3. MILNE EDWARDS (1840), Crust., 3. 324. *Acaste Downingiæ*, GOLDFUSS, Syst. Uebersicht der Tril., Neues Jahrb. (1843), 563. *Phacops macrophthalmus*, BURMEIST. (1843), Org. der Tril., 139, 140, and in ed. 2. (1846), p. 92. *Phacops Downingiæ*, EMMRICH, Neues Jahrb. (1845), 40. pl. 1. fig. 2. [icon mala]; Transl. in Taylor's Scient. Memoirs (1845), vol. iv. pl. 4. fig. 2. PHILLIPS and SALTER, Memoirs Geol. Surv. (June 1848), vol. ii. pl. 1. p. 239, 336. pl. 5. fig. 2. 3. 4. M'COY (1851), Synopsis Pal. Foss. Woodw. Mus. 160.

Junior.—Asaphus subcaudatus, and *A. Cawdori*, MURCHISON, Sil. Syst. pl. 7. fig. 9, 10. *Phacops subcaudatus*, SALTER and PHILLIPS, l. c. 239.

One of the most common, and certainly one of the most elegant trilobites in the Silurian System—occurring in abundance wherever Upper Silurian strata are found. It is a very characteristic fossil of the Dudley limestone. And yet, perhaps, there is no species of trilobite which has been so much misunderstood; the confusion apparently arising from this circumstance—that it is rarely, if ever, found out of Britain; although somewhat similar species have been identified with it, both British and foreign. It was named in compliment to Mrs. Downing, of Dudley, from whose cabinet the figures in the "Silurian System" were drawn.

Description.—Length from an inch and a half to two inches. The general form long-ovate, the anterior end being considerably broader, and with the axis following the same lines, and regularly tapering from head to tail. The surface is moderately convex, the axis raised above the sides, not separated by deep furrows except in the head, and more convex in the thorax than in the head or tail. The head is somewhat less than a semi-circle, though just twice as long as broad, the general outline being rather triangular, from an indentation in the curved outer margin on each side of the wide glabella; the front is not produced, but angular. The glabella occupies more than one third the width of the head in front, and tapers but little backwards, having nearly straight and parallel sides; it rises considerably above the cheeks, but is rather depressed than convex, especially the forehead lobe, which is not at all inflated, but slopes gradually to the narrow front margin, from which it is separated by a shallow furrow. Neck lobe strong, broader than the first basal lobes, which are transverse and linear; the middle pair are broader than these, and oval, the direction of the first and second furrows determining their shape—the lower furrow curves downwards, and reaches the side of the glabella; the upper one, which is abbreviated, curves the reverse way; the upper lateral lobe is transverse, scarcely triangular, and bounded above by a sigmoid furrow, which runs very obliquely out above the eye. All the furrows stretch equally towards the middle of the glabella, leaving but a narrow space between their ends; between the upper pair a short longitudinal depression occurs. The lobes are not swelled between the furrows, but the surface is even and the furrows shallow (they are, however, sharply defined on the internal cast); the neck furrow and basal furrows are strong—the two upper ones very faint.* The cheeks are steeply bent down, their outer margin not distinguished by any furrow, and they slope gradually from the eye, without any ridge or groove beneath the latter; the neck furrow is continued almost to the posterior angle, which is rounded off and only shows a slight projection (fig. 10, *c*) in the place of a spine. The facial suture cuts the outer margin in a curved line in front of the posterior angles, and opposite the base of the eye; on the under surface of the head (fig. 5) the suture cuts the margin further backward (*b b*). Above the eye it continues along the axal furrow and round the front of the glabella just outside the marginal furrow. Eyes rather large, conical, rising in some specimens nearly to the level of the glabella, placed about half-way up the cheek, near to the two upper glabella lobes, and occupying their length: eye lobe with a raised outer margin; lentiferous surface broad, with about 155 lenses in each eye, each vertical row containing eight. The cornea is convex over the lenses, and the intermediate flattened spaces are finely granular, the granules forming a rough hexagonal network toward the base of the eye; the lenses are nearly their own diameter apart, but this varies much in different individuals, the space being often much less (figs. 7, 8).

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* Memoirs Geol. Survey, vol. ii. p. 1. pl. 5. fig. 2.

On the under side of the head, the incurved front portion (which, as in all the genus, is continuous across,) is broad (fig. 5, *a*), and granular, like the upper surface; it supports the broad base of the hypostome, which is also granulated. This organ is subquadrate but broadest at its base, and very regularly convex, almost tumid; a faint concentric furrow running round the sides and tip just indicates a narrow margin, more flattened than the other parts; there are no lateral furrows, but high up on each side is a small tubercle. The tip is straight and somewhat truncate, and the exterior angles are cut off so as to render the end somewhat polygonal; but there are no traces of projecting teeth, and the appearance of the apex is obtuse. The entire organ is much narrower than the glabella, and not above half its length, but from the position of its base it reaches as far backward as the middle pair of glabellar furrows. And these glabellar furrows, as Burmeister has shown, doubtless indicating the position of the jaws and accessory parts of the mouth, the hypostome must have served the office of labrum or upper lip.

Thorax considerably longer than the head, of 11 not very highly arched rings—the axis moderately convex, of nearly equal breadth with the pleuræ. These, which are traversed by a straight deep groove, (fig. 10, *d*), are curved rather abruptly downwards at the fulcrum (fig. 10, *e*), which anteriorly occurs at the inner third of their length, and in the posterior ring does not reach further than one fourth. The anterior edge of each pleura is sharpened or facetted* to pass under the preceding one, and the posterior edge is thickened. Each pleura is much bent forward at its end, which is deeply notched

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* M'Coy, Annals Nat. Hist. (Dec. 1849.)

(figs. 12, 13), and on the under side of each, in front of this notch, is placed a tubercle (fig. 13, *a*). When the animal was in the act of rolling up, the tubercle prevented the next ring from being pushed too far forward; the tail, too, has them on its anterior edge. Some such contrivance as this, for giving compactness to the rolled up form, is probably general in trilobites, and Mr. John Gray, of Dudley, who first drew my attention to it, has succeeded in developing nearly the whole of the under surface of this species.

The tubercles just mentioned occur on the incurved crustaceous portion (fig. 13, *b*) of the pleuræ, which, in this species is but narrow, while in *P. caudatus*, Decade II. Pl. 1., it extends some distance inwards.

The tail is sub-triangular and rather pointed, nearly twice as wide as long, and moderately convex; the axis is more convex, but does not rise abruptly from the general surface, nor is it separated from the sides by any distinct axal furrows. It is conical, not so wide as the sides, extending to about four fifths of the length of the tail, with an obtuse scarcely prominent end; it is crossed by five distinct and two or three obscure rings. The sides have five or six rather deep and curved furrows, which end abruptly at the thickened margin; smaller and shallower furrows occur between each of the principal ones for the whole length. The incurved under margin is narrow but thick.

The whole of the upper surface, and the incurved margins of the head and tail, are covered with fine, close, equal granulations; the hypostome is also equally rough—none of the grains become tubercles, but all remain of equal size.

Variations.—Among the specimens in the cabinets of Messrs. Fletcher and Gray, occur one or two with the eyes (fig. 3) very considerably larger than usual, so as almost to equal those of *P. Stokesii;* the specimens, however, clearly belong to the species we are describing. The following measurements in lines will give an idea of this difference, which is represented in our figure 3:

Ordinary specimen :—		*Large-eyed variety :—*	
Length of head - -	5 lines.	Length of head - -	5¼ lines.
Length of the eye - -	2 „	Length of the eye -	2¾ „
Height of eye - -	1 „	Height of eye - -	1½ „

The surface, therefore, in one case is nearly double that of the other, and the number of lenses is increased to about 180, the lenses themselves being each a little larger and not distant from one another more than half their diameter. Another specimen, in

Mr. Gray's cabinet (fig. 8.) has the lenses decidedly small, distant their full diameter from each other, and the intermediate granulations more elevated and connected into zigzag lines. Fig. 7* shows the ordinary surface of the eye. Some specimens have the axis of the body more prominent than others, and the tail is more pointed in some than in others. The glabella varies in width, and divergence of the axal furrows; many specimens having the sides nearly parallel, as in fig. 4, others, as fig. 10, somewhat more clavate. And in a dwarf variety from the Caradoc sandstone, found by Professor Sedgwick at Llanrwst, in North Wales, the clavate form is very marked. Occasionally (fig. 4) the two front furrows become quite obscure; but this is a rare variation. These two upper furrows are always shallower than the lower one and neck furrow, and they show but little in the internal cast; but they are never quite lost. Fig. 14 is from a fine large head from Ledbury, in Mr. C. Stokes's cabinet; the glabella furrows are remarkably deep, considering it is an internal cast, and the lobes somewhat more tumid than usual.

Affinities.—The variation just noticed gives the specimen a great resemblance to a nearly allied species, which, however, belongs to the section *Phacops*, viz.—*P. Stokesii*, M. Edwards, (*P. macrophthalma*, Brongn., t. 1. f. 5., figured in Mem. Geol. Surv., vol. ii. pt. 1. pl. 5. fig. 1). This, which is abundant at Walsall and Dudley, and frequently met with in the Wenlock limestones of the Malverns, is easily distinguished from all the varieties of *P. Downingiæ* by the shape of the lowest glabella lobe, which in this is narrow, very strongly marked off from the rest of the glabella by a nearly continuous transverse furrow, and its extremities are terminated by two rather small but strongly marked tubercles, while in *P. Downingiæ* this lobe is always linear and destitute of tubercles. The uppermost glabellar furrow is bent as if broken, while in *P. Downingiæ* it is a simple sigmoid curve. The tail of *P. Stokesii* has only two or three of the upper furrows of the axis and sides distinct; *P. Downingiæ* has them all marked, and the side furrows interlined by finer ones. But there is a Lower Silurian species, hereafter noticed, still more nearly resembling ours in all its parts—the *P. apiculatus*, Salter. In this the general shape of the head, and of the glabella and its lobes, have just the same appearance as those of our species, but a careful comparison will show marks of decided difference in all these parts. In the *P. apiculatus*, which is as common in the Lower as the *P. Downingiæ* in the Upper Silurian, the head is longer, and the glabella more elongate and narrower, and more convex anteriorly; from its greater length, too, the lobes do not appear so crowded; they differ also in shape. The lower or basal pair are not linear and transverse, but subtriangular, and are cut off by a shallow depression from the body of the glabella (as in the sub-genus *Phacops*), and the neck lobe rises in the middle between them. The second or middle furrow extends to the glabella edge, and is bent down there; and the upper one is more deeply impressed, and ends in a decided notch at the glabella margin, (even of this there is some trace in our species, but not nearly so distinct). There is an important difference, too, in the presence of a small spine at each of the head angles. The tail in *P. apiculatus* is decidedly triangular, and at the apex pinched up and drawn out into a recurved spine.

With *P. macrophthalma*, Brongn., t. 1. fig. 4., it really has little in common. The head of that species* is far too long in proportion to the breadth for *P. Downingiæ;* the forehead lobe is too clavate, and the head long, not transverse, and with a strongly pointed front, as represented in the original figure. The eyes, cheek angles, glabellar furrows, and tail all differ widely from those of the species before us. From *P. Brongniarti*, considered the same with it by Col. Portlock, it differs considerably. In that species, independently of the great length of the head, the glabella is widely clavate, with its basal pair of lobes obsolete, and the eyes enormous; the furrows also of the tail are almost twice as numerous. It appears to be the pointed form of the head, not, however, very conspicuous in *P. Downingiæ*, which has suggested the reference of this and of other trilobites to our species. *P. microps* (Green), as far as can be ascertained from his cast, No. 6, much resembles *P. Downingiæ*, but it cannot be identified. *P. Phillipsi*, Barrande, is very like our species, but the glabella furrows do not converge, and the upper ones are nearly obsolete.

History.—Had Brongniart not figured two trilobites with large facetted eyes under one common name, thereby implying that they were at least closely related, it is not probable that any succeeding author would have identified the species we are describing with either of his figures. But as one of these was from an original drawing, made for Mr. Stokes from a Dudley specimen, it was likely that both British and foreign naturalists should conceive the common Dudley species, with a pointed front, to represent the more pointed variety of Brongniart. Green, in his description of the *C. macrophthalma*, 1832, noticed the great difference between the two figures: and, referring to a fine slab of Dudley trilobites, noted that these agreed exactly with the description given by M. Brongniart of the head of his species; and one of Green's published casts is from a British specimen.

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* M. Ad. Brongniart's kindness permitted us to examine the original figured specimen at the Jardin des Plantes in 1849. Of four specimens arranged as *P. macrophthalma* in this collection, the figured specimen is the only one without the name attached. One, particularly labelled by Alex. Brongniart as *P. macrophthalma*, has a more clavate glabella than the true species, and is a decided *Cryphæus*, from the United States.

Professor Buckland, who in 1836 published a drawing of this species in the Bridgwater Treatise, conceived it to be represented by the more pointed form of *P. macrophthalma*, (Brongniart, fig. 4), and named it accordingly; and Sir R. I. Murchison followed this view, at the same time rightly distinguishing it from the obtuse headed species (fig. 5 of Brongniart), which occurs, though rarely, in company with it at Dudley. He considered the latter fossil, which has enormous eyes, to be more properly the type of Brongniart's species; and gave the new name to that one which was conceived to represent his figure 4. Milne Edwards in 1840 recorded it as distinct from either of Brongniart's species; and as the French fossil with a pointed front evidently furnished Brongniart with his description, retained his name, *Calym. macrophthalma*, for that species, and gave that of *C. Downingiæ* to the present one. He also applied a new name, *C. Stokesii*, to the rarer British fossil represented by Brongniart's fig. 5. In this view all naturalists are now agreed. In the meantime, and immediately after the publication of the Silurian System, Professor Emmrich had established the very natural genus *Phacops* for all those trilobites with largely facetted eyes and 11 segments to the thorax; and he of course quoted the present species under the genus, but supposed it might probably be a variety of his Bohemian species, *P. proævus*. He afterwards, 1845, admitted it under the present name. Professor Goldfuss, too, in the general systematic Review of Trilobites, published in the Neues Jahrbuch for 1843, had admitted the species; and perceiving the great distinction that existed between those forms with all the glabella furrows distinct and strong, and those in which the anterior ones were obsolete, he separated the group which includes the present species under the term *Acaste*, reserving *Phacops* for those species with inflated heads and obscure glabella furrows, which Dr. Emmrich had already pointed out in his Dissertation as the type of his genus. The latter, in his systematic table of the genera, published in the Neues Jahrbuch for 1845, objected to this arrangement, and grouped together the two sections just adverted to as constituting a sub-genus *Phacops*, while he formed the section *Dalmannia* for the more expanded forms, such as *P. caudatus*, *P. Hausmanni*, &c.*

Professor Burmeister had already, 1843, regarded our species as a synonym of *P. macrophthalma*, Brongn., and has repeated this reference in his second edition, 1846. And Lieut.-Col. Portlock, in his admirable work on the Geology of Tyrone, endeavoured to escape from the difficulty by proposing a fresh name, *P. Brongniarti*, to include Brongniart's and Murchison's species, as well as a new and perfectly distinct form, discovered by himself; thus adding innocently to the confusion. In the Mem. Geol. Survey, 1848, I returned to Milne Edwards' correct classification of these species, and described both the English forms. Professor M'Coy has since confirmed their distinctness, and we may now consider *P. Downingiæ* as having established its claim to rank as a distinct British species, highly characteristic of the Upper Silurian rocks, and unknown, so far as we are able to learn, in other countries.

British Localities and Geological Position.—CARADOC SANDSTONE to LUDLOW ROCK.—Caradoc Sandstone; Moel Seisiog, and other places near Conway and Llanrwst, North Wales (dwarf specimens). Wenlock Shale; Bryn Craig, &c., Usk; and Slate Mill, Hasguard, in South Wales. Wenlock Limestone; west of Hereford Beacon; Ledbury; Malvern Hills; Dudley and Walsall, abundant. Lower Ludlow and Upper Ludlow Rocks of the Abberley Hills. Upper Ludlow; Underbarrow and Benson Knot, Kendal; Pont-ar-y-Llechau, near Llangadoc, South Wales; Ludlow Rocks, Golden Grove, and other places south of Llandeilo.

EXPLANATION OF PLATE I.

Fig. 1. *Phacops Downingiæ*, of ordinary size; Dudley limestone. (Collection of John Gray, Esq.) At *b*, the outer termination of the facial suture is seen.

Fig. 2. Do.; a rolled-up specimen, same locality. (Collection of T. W. Fletcher, Esq.)

Fig. 3. Do.; variety with very large eyes, each with about 180 lenses. Same locality and collection.

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* As we think, however, that there are three distinct groups, we have adopted the term *Acaste* for the present sub-genus, and left the species with inflated and lobeless glabella in the section *Phacops*. In this latter view we have the sanction of the greatest authority on trilobites, M. de Barrande, whose great work, just received from the publisher, will long be the standard for reference. Otherwise we should have been unwilling to disturb the nomenclature adopted by Professor M'Coy, who has given to the latter group the new name *Portlockia*, reserving *Phacops* for those species which have the glabella lobes distinct, but have not the expanded form or numerous tail segments of *Dalmannia*.

United Kingdom.

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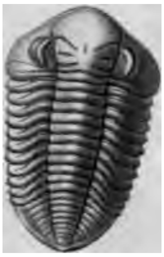

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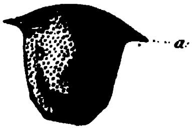

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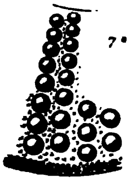

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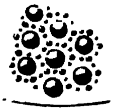

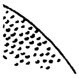

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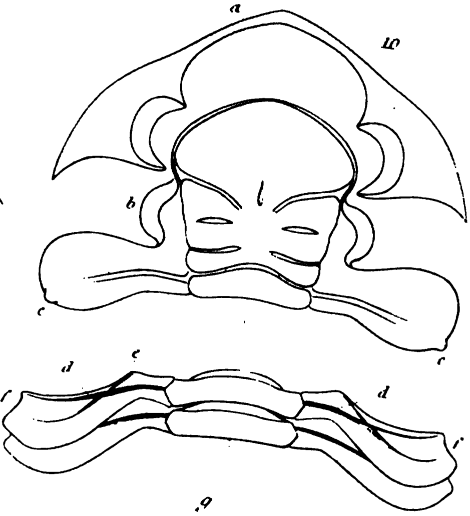

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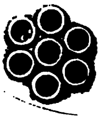

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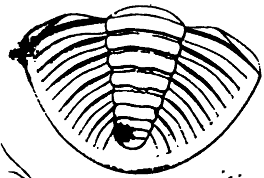

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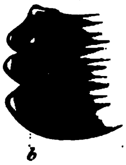

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Fig. 4. Glabella of a specimen from the Wenlock limestones of the Malverns, with the two upper furrows nearly obselete; the lower ones are stonger than usual; a rare variation. (Coll. Mus. Pract. Geol.)

Fig. 5. Under side of the head, showing the entire rostral portion *a*, the termination of the facial suture on each outer side at *bb*, much further backward than on the upper surface (see fig. 1, *b*); *c*, the obtuse hypostome or labrum. (Coll. Mr. John Gray, Dudley.)

Fig. 6. Hypostome of last specimen, magnified. The basal processes (*a*) extend even further outwards in some specimens, and are probably attached beneath to the ends of the upper glabella furrows.

Fig. 7. Eye of an ordinary specimen, natural size. Dudley.

Fig. 7*. Portion of do., highly magnified, showing the separate convex portions of the cornea over each lens, with granules on the interspaces.

Fig. 8. Portion of the eye of another variety, with the lenses proportionally smaller and more distant, and the granules collected into an hexagonal network between them. Dudley.

Fig. 9. Highly magnified cast, in fine silty mud, of the interior of the eye, showing the cups from which the lenses have fallen out. These cups therefore occupy the place of the depressed tip of the crystalline or vitreous body. (Burmeister.)

Fig. 10. Enlarged specimen, the head divided at the facial suture, showing the first segment, *a*, as an entire ring or segment which bears the eyes. On the second ring, *b* is the upper eye lobe; *c*, the tubercle or rudimentary spine; at *d*, the pleural furrow is shown, and at *e*, the fulcral point of a middle thorax joint; *ff*, the notched tips of the pleuræ; *g*, the tail.

Fig. 11. Part of the front of the head and glabella, to show the equal granulation of the surface.

Fig. 12. Magnified notched ends of the pleuræ (upper side), showing their surface to be granulated even over the facetted portion, *b*; at *a* the tubercle is shown, which is better seen in the next figure.

Fig. 13. Magnified under side of three pleuræ, showing the narrow incurved under portion *b*, and the tubercles which serve as buttresses in rolling up, *a*.

Fig. 14. Internal cast of a large head, from Ledbury, Wenlock limestone (Mr. C. Stokes's cabinet); the furrows are much broader and deeper than usual.

Fig. 15. Tail, natural size, from Dudley, to show the sub-triangular pointed form usual in the species.

Other British Species of Phacops, of the Section ACASTE.

1. *P. apiculatus*, *Salter* (1852), in Prof. Sedgwick's Synops. Classific. Palæozoic Rocks, fasc. 2, Appendix, iii. pl. 1 G. f. 17–19. *Portlockia? apic.* M'Coy (1851), ib. fasc. 1. p. 162.

P. omnino P. Downingiæ simillimus; sed capite longiore, glabellâ elongatâ, antice convexiore, lobis basalibus circumscriptis subtriangulatis nec transversis; sulco medio glabellari longiore, supremo distinctiore; oculis elongatis subdepressis; angulis posticis capitis brevissime mucronatis; caudâ ad apicem paullo compressâ et in apiculum recurvum brevem productâ; axi angustato.

Localities.—Common in the Llandeilo flags of North Wales, and in the Caradoc sandstone of Hope Bowdler and Acton Scott, Shropshire. [Geol. Surv. and Woodw. Mus.]

Heads of this species have also occurred in the hard quartzites of the coast of Cornwall, at the Great Peraver, in company with *Calymene*, *Orthis* and other Silurian forms.

2. *Phacops Brongniarti*, Portlock (1843), Geol. Rep. Tyrone, pl. 2. fig. 8. (excl. ref.) *P. Murchisonii*, ib. fig. 9.

P. biuncialis, elongatus granulatus, modice convexus; capite longo trigono, fronte angulato subrecurvo; glabellâ ad basin contractâ anterius valde dilatatâ nec convexâ, lobis utrinque tribus radiantibus; lobo antico maximo triangulato, a frontali sulco valido—a medio sulco leviore—sejuncto; lobis infimis minutis hemisphæricis circumscriptis sese remotis; lobo verticali eminentiore; oculis maximis, a lobo frontali usque ad sulcum verticalem tractis; angulis genarum obtusis; thorace axi convexo angustato, lateribus parallelis abruptè deflexis; pleurarum apicibus rotundatis, fulcro intra medium posito; caudâ trigonâ, axi longe conico angustissimo fere ad finem caudæ extenso, decies annulato; apice prominulo; lateribus 5-costatis, costis per totum divisis, nec marginem lævem attingentibus.

Col. Portlock had united with this species both the *P. macrophthalma* of Brongniart, and *P. Downingiæ*, Murch. They are however, as above stated, quite distinct species. The present is well characterized by the pointed front and contracted base of the glabella, as well as by the large eyes, which have each 170 lenses.

Localities.—Bala and Llandeilo Rocks: Tyrone; Carrickadaggan, Wexford; Llanfyllin, and other places, N. Wales.

3. *P. Dalmanni*, Portl. l. c. f. 7.

Omnino precedenti simillimus—caudâ multi-annulatâ, oculis maximis, glabellâ ad basin contractâ, granulosâ; sed capitis fronte rotundato, nec producto; [an forsitan fæmina inermis?]

This neat species occurring with the last, and of the same or of rather less dimensions, so much resembles it in form, proportion, and sculpture, that we are compelled to regard it as of the same species, and as indicating either a variety with a rounded front, or, what is more likely, the female form. Portlock's original specimens are all of one character, and the front appears to have been really rounded, not broken off.

Locality.—Desertcreat, Tyrone.

4. *P. Jamesii*, Portlock, G. Report, pl. 3. fig. 10. (mala).

P. unciam latus; capite semicirculari, bis quam longo latiori, fronte angulato, marginato, crasso; glabellâ fere planâ tuberculatâ antice latissimâ postice ad dimidium contractâ, lateribus rectis; lobo frontali latè triangulato, oculis impendente; cæteris radiantibus,—supremo maximo triangulato, medio lineari obliquo haud abbreviato, basali transverso; lobis omnibus fere ad medium glabellæ, spatio angusto interjecto, conniventibus; genis lente declivibus marginatis, angulis obtusis; oculis abbreviatis valde curvatis; (thorace — ?) caudâ [unâ cum capite congregata] rotundatâ, quam longâ tertiam partem latiori, depressâ; axi satis magno conico, marginem nullo modo attingente,—annulis 8–9; lateribus sulcis 6–7 æqualibus, læviter interlineatis.

Portlock's figure but imperfectly expresses the great width and flatness of the glabella, which is not the result of pressure; the tuberculation covers the glabella only, while the cheeks are merely granulated. The shape of the glabella and its radiating lobes, and the short curved eye, approximate this species nearly to the next, from which the glabella and pointed front of the head readily distinguish it. The head too is not so broad in proportion.

Locality.—Tyrone; in calcareous sandy schist, Waterford; also in sandstone at Newtown on the Suire, in the same county. [Geol. Surv. Coll.]

5. *P. alifrons*, Salter, in Appendix to Sedgwick's Brit. Pal. Foss. l. c. ii. t. 1 G. f. 12–14, M'Coy, ib. 159.

P. capite sesqui-unciam lato, gibboso, tuberculoso, antice truncato, bis quam longo latiori; glabellâ elevatâ sed paullum convexâ, ad basin angustatâ, superne dilatatâ obtusâ, lateribus subrectis; lobo frontali brevi transverso limbum crassum impendente, et utrâque angulis *tumidis cum margine genarum confluentibus; lobis lateralibus tumidis, supremo subtriangulato anticè obliquo, reliquis fere rotundis brevissimis; genis declivibus tuberculatis marginatis, angulis rotundatis; oculis elevatis brevibus curvatis; pygidio semicirculari tumido; axi lato convexo* 8–9-*annulato, apice obtuso nec marginem attingente; lateribus convexis, costis* 7–8, *radiantibus simplicibus, margine angusto.*

The peculiar character of this species, which a good deal resembles *P. sclerops* Dalman, consists in the absence of any separating furrow between the upper lobe of the glabella and the outer margin of the cheek, the glabella thus seems to be drawn out into it on either side.

Localities.—Capel Garmon, Llanrwst; near Penmachno; Pont-y-Glyn Diffwys; and Bala; all in the Bala or Llandeilo rocks of North Wales.

6. *Phacops Jukesii.—n. sp.* [*P. sclerops*, var., Dalman, Pal., t. 2. fig. 1 *g*. (mala) ?]

P. capite unciam et plus lato, fere quam longo ter latiore, convexo (granuloso ?); glabellâ haud elevatâ antice valde dilatatâ, postice contractâ, utrinque tri-lobâ; lobo basali transverso lineari, secundo paullo majore rotundato, supremo magno triangulato, frontali maximo transverso toto oculo elevato brevi curvato imminente, lobo cervicali elevato nec lato; genis latis marginatis, [*angulis rotundatis ?*]*; sulco verticali fortè exarato; lineâ faciali impressâ; sulcis axalibus profundis.*

This curious species, which we have only just now detected in the collections from Bala, differs materially from the next, in the comparatively equal size of the lateral glabella lobes. The upper one is large and triangular, but not nearly so large as in *P. conophthalmus*, and the second is distinctly rounded and larger than the basal lobe, instead of being contracted and almost lost, as in that species.

Locality.—Bala limestone, west of Gelli grin, Bala. [Survey Coll.]

7. *P. conophthalmus*, Bœck. sp. [*Calym. sclerops*, var. Dalman, Pal., t. 2. fig. 1 *d?*] *Tril. conicoph.* Bœck Gœa Norveg. (1838), 1. 4. *Phacops con.*, Emmrich Dissert. 21. *Asaphus Powisii* (head only), Murch. Sil. Syst., t. 23. f. 9. *Calym. Odini* (Eichw.), De Vern. Geol. Russ., t. 27. f. 8. *P. sclerops*, Burm., ed. 2. (1846), t. 4. f. 5. excl. syn. (icon bona, ab editione prima multo emendata.) *P. conophthalmus*, ib. p. 91. *Chasmops Odini*, M'Coy, l. c. t. 1 G. f. 22, 23. *P. conophthalmus*, Angelin, Pal. Suec. (1852) t. 7. f. 5, 6.

P. ovatus, magnus; capite valde transverso, fere quam longo ter latiore, granuloso, convexo; glabellâ convexâ, anticè valde dilatatâ, postice angustatâ, utrinque bilobâ, lobo mediano omnino contracto obsoleto, basali transverso lineari, supremo maximo triangulato, supra paullum sinuato; frontali rhombo-trigonali maximo nec oculo imminente; lobo cervicali lato; genis convexis latè marginatis; angulis in cornua lata extensis [*interius rotundatis*] *oculo brevi valde curvato; lineâ faciali impressâ; cauda (associata) lata punctata, vix marginata, axi conico, lateribus angustiore,* 9–10 *annulato; costis lateralibus* 8 *arcuatis, omnibus duplicatis.*

This remarkable species is abundant in the Silurian strata on the Baltic coasts; it is equally common in Britain, but although fragments are abundant, we have only seen perfect specimens of the head in the Woodwardian Museum. I collected these in company with Professor Sedgwick, and with them was associated the tail above described, which could hardly belong to any other species. It is found with fragments of the head in some other localities, and agrees well also with that figured by Professor Burmeister. But the figure given by Angelin represents the tail as considerably more pointed, and we have specimens from Wales more of this character; there are other species of *Phacops* in which similar variations occur. The heads figured in the "Silurian System," from the Caradoc sandstone, belong to this species. Angelin has figured two other Phacops with very similar lobes to the glabella, but it is possible his *P. bucculenta* and *P. macroura* may prove but varieties of this.

We have seen the eyes of this species, and they are reticulated as in other species of Phacops. But from their greatly curved shape they are generally broken off, and this has led Professor M'Coy to the establishment of his genus *Chasmops*, which had better be expunged, as this group is so closely connected with the ordinary *Phacops* by means of such species as *P. Brongniarti* and *P. Jukesii.*

Localities.—In Bala Limestone; Llansaintffraid Glyn Ceiriog, south of Llangollen; Alt-yr-Anker, Meifod, North Wales [M'Coy], Welshpool [Sil. Syst.]; Llanfyllin, Montgomeryshire; Llanbedrog, Carnarvonshire [Survey Coll.]: Applethwaite Common and Coniston, Westmoreland [M'Coy]. Caradoc Sandstone; Cheney Longville, Shropshire [Sil. Syst., figured specimen]; Acton Scott, &c., abundant.

Section ODONTOCHILE (Dalmannia), DECADE II. PL. 1.

Additional British Species.

P. mucronatus, Brongn. sp. *Entomostrac. caudatus*, Wahl. Nov. Act. Soc. Ups., v. 8. t. 2. f. 2. *Asaphus mucr.* Brongn., Cr. Foss. t. 3. f. 9. Dalman, Pal., t. 2. f. 3 *a b.* *Phacops*, Emmrich (1839), Diss. 24. N. Jahrb. 1845. Burmeister, ed. 1. p. 113., and ed. 2. (1846), p. 95. (excl. syn. Murch. "Sil. Syst.") Angelin, Pal. Suecica (1852), t. 8. f. 1.

P. triuncialis et supra; glabellâ convexâ, anticè parum dilatatâ, utrinque lobis tribus subæqualibus transversis, sulcis longis satisque profundis sese separatis; caudâ latè triangulari acuto, axi subconvexo limbum planum haud æquante, in 9–12 annulos et appendicem trigonalem diviso, appendice in apicem caudæ brevi-mucronatum percurrente; lateribus costis 7 planis, sulcis angustis acutis valde curvatis et cum tot lineis intermediis profundioribus ad apices confusis; margine angusto nec distincto.

Portions of the head and perfect caudal shields of this rare species have been found in a stratum over the bed of volcanic ash at Pen-y-Rhiw, west of Bala, where it is to be hoped other collectors may obtain fresh specimens. The head is not complete enough to give the diagnosis. Our Bala specimens, as well as those from Sweden in Sir R. I. Murchison's cabinet, have but 9 rings and a triangular terminal portion to the axis of the tail, but in a specimen from Haverfordwest part of this terminal portion is annulated, and there are 12 rings. The lateral ribs are much arched at their ends, and strongly duplicate, of double furrows, each pair uniting at their tips in a broad depression. The apex is recurved; the mucro varies in length.

Localities.—Pen-y-Rhiw, west of Bala [Survey Coll.]; Haverfordwest, Pembrokeshire [Mrs. Day's cabinet]; in Llandeilo flags.

P. amphora, n. sp.

P. caudâ magnâ biunciali elongatâ, convexissimâ, fere semicylindricâ; sulcis axalibus fere obsoletis; axi lato nec eminenti, marginem caudæ haud attingente, in annulos sexdecim subplanos diviso, apice obtuso; lateribus valde curvatis deflexis, costis 14–15 *planis, sulcis acutis separantibus,—costâ quâque lineâ medianâ lævi elevatâ (sub cortice impressâ!); margine angusto inflexo, apice obtuso (emarginato?).*

Very like in general form to *P. truncato-caudatus*, Portl., from which it is at once distinguished by its convex form (almost like that of a half cask or barrel), and the axis not at all distinct from the sides—the axal furrow being almost obsolete; this latter character is very unusual in Phacops. Along the middle of each of the flattened side ribs a narrow and but slightly elevated ridge runs the whole length; on the internal cast this is represented by a depressed line of connected dots. Something similar, but less distinct, occurs in the allied species above quoted.

Locality.—Grug Quarry, near Llandeilo [Survey Coll.]; one fine specimen was presented by Mr. Williams, of that place. In Llandeilo flags.

J. W. SALTER.

August, 1853.

BRITISH FOSSILS.

DECADE VII. PLATE II.

CHEIRURUS BIMUCRONATUS.

[Genus CHEIRURUS. BEYRICH. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Head strongly trilobed; glabella with three lateral lobes, the basal ones circumscribed; eyes facetted; facial suture ending on the external margin; a rostral shield: Barrande. [Cheeks scrobiculate]; hypostome inflated, oblong, truncate, with a marginal furrow and lateral auricles; thorax of 11 joints, the pleuræ strongly nodular as far as the fulcrum, the ends free and pointed; tail of few, 3 or 4, segments, free at their ends.]

DIAGNOSIS. ***C. grandis; glabellâ superne latiori, sulco frontali et oculari obliquis propè medium glabellæ terminatis; lobis inferis trigonis (ætate rotundioribus) sejunctis; genis glabellâ angustioribus, oculis medianis, spinis posticis parallelis; thorace pleuris trituberculatis; caudâ parvulâ, utrinque pleuris tribus subæqualibus ad basin brevisulcatis, apicibus robustis, arcuatis.***

SYNONYMS. Var. α. *Bimucronatus—caudâ mucrone centrali nullo.*

Calymene speciosa [DALMAN (1826), Pal., pp. 58, 76 ?] HISINGER (1840), Lethæa Suecica, Suppl. 2d. t. xxxix. fig. 2. *Paradoxides bimucronatus*, MURCHISON (1839), Sil. Syst., pl. 14. fig. 8, 9. MILNE EDWARDS (1840), Crustac., vol. iii. p. 343. *Arges bimucr.* GOLDFUSS (1843), Neues Jahrb. 544. *Cheirurus bimucronatus*, BEYRICH (1845), über einige Böhmische Tril., p. 18, 19. *Cheir. ornatus* (Dalm.), *β*, *bimucronatus*, BRONN. Ind. Palæont. (1848), 1. 286. *C. speciosus*, SALTER (June 1848), Memoirs Geol. Survey, vol. ii. pt. 1. pl. 7. fig. 4, 5, 6. *Ceraurus Williamsii*, M'COY (Dec. 1849), Ann. and Mag. Nat. Hist., p. 408, Pal. Foss. Woodw. Mus. (1851), pl. 1 F. fig. 13.

VAR. *β*. *Centralis*, fig. 16.—*caudâ mucrone centrali brevi*, Mem. Geol. Surv., l. c. fig. 7.

The subject of our present notice received some degree of illustration in the second volume of the Memoirs of the Geological Survey, and we need not repeat here the figures which indicate the large size to which the species grew, but take advantage of a beautiful and nearly perfect specimen, found near Aymestry, and lent to us by the Rev. T. T. Lewis, whose valuable labours are so frequently acknowledged in the "Silurian System." Messrs. Gray and Fletcher, of Dudley, have kindly enabled us to complete the details, and the figures in this plate are nearly all drawn from Upper Silurian specimens, while those previously given, with one exception repeated in this plate, were from the Llandeilo flags of South Wales.

The genus to which this rather common fossil belongs is highly interesting for the remarkable sculpture of the body rings, which are broken up into a number of prominent swellings divided by deep furrows, and have their ends freely extended into sharp points, which are so widely distant from each other, that it would require the animal to roll up to bring them into contact. The tail is made up of a few similar rings, cohering only at their base, and having the ends also free and pointed. The nature of the eyes also is worthy notice, inasmuch as they are covered by a facetted cornea, like that of *Phacops caudatus*, and not, as in most trilobites, with a smooth one. The facial suture, in this and one or two closely related genera, runs as it does in *Phacops*, to the outer margin of the head. The shell or crust is strong and calcareous, the furrows of the head well marked; the hypostome or labrum has a considerable resemblance to that of the genus above mentioned, and the number of rings in the thorax is the same—so that it is almost certain, much as the general appearance resembles *Paradoxides*, that there is a really close affinity between it and those species of Phacops which have the tail fringed with long spines.

Description.—One of the largest of trilobites; it measures occasionally 15 inches, and probably more, judging from the proportions of the large fragments previously figured* to that of perfect specimens of a smaller size. Those found at Dudley are not above one and a half or two inches long,—specimens from the Malverns are much larger. Length to breadth as three to two; the head occupies fully one third the length, and is a little broader than the body. General form moderately convex, and oblong, but narrowed suddenly towards the posterior end; the sides of the thorax and tail deeply serrated by the projecting ends of the segments. The animal is sometimes found half coiled up; the pointed ends of the pleuræ closing together and overlapping each other (fig. 2.)

Head rather more than a semicircle,—the obtuse front projecting; glabella gently convex, equal in breadth at the base to the cheeks, above considerably broader, marked with three strong furrows on each side besides the neck furrow, the lowest being directed obliquely downwards and joining the neck furrow before reaching the middle; it thus encloses a spherical triangle as a basal lobe. In older specimens this lobe is somewhat squarer, and the furrow more curved. The other furrows curve but little downward, and are variable in length, but usually extend more than one third across the glabella on each side. The furrows on the glabella, as well as the axal furrows, are sharp, but not broad or deep exteriorly, although they are so on casts of the inner surface. Forehead lobe of moderate size, half as long as the entire glabella, and on the sides overhanging the other lobes,—in front it is somewhat produced and occupies all the margin. The glabella is neither gibbous nor depressed, a line taken from the front edge to the neck furrow presenting a regular and gentle convexity. Cheeks subtriangular, not so wide as long, with a broadish margin distinctly separated by a furrow, which meets the strong straight neck furrow at the posterior angles; these angles are spinous, the spine short and directed backwards. The eye is placed more than half-way up the cheek, and not close to the glabella, it is opposite the middle furrow,* and is rather small, supported by a raised rim below; the eyelid is narrow and indented,—the lentiferous surface (fig. 7) very convex, supine, and covered with minute, closely set, convex facets with no spaces between them. Our figure, 7*, represents each facet as with a minute pit upon it, but this is due to wear, (at *a*, a lens is seen in the natural condition). Above the eye the facial suture takes a sigmoid curve, and cuts the margin exactly where the axal furrow ends on it; below the eye it turns directly downwards to the smooth border, which it cuts considerably in advance of the posterior angle, and in an oblique direction, so that it reaches further back on the lower side than on the upper. We do not know the course of the suture in front,—it is probably direct across, beneath the front margin, leaving the cheeks united there, as in *Sphærexochus*, next described. The surface of the glabella is sparsely covered with small granules (fig. 1*, *a*); the cheeks are largely scrobiculate, (*b*, *c*), and the wings or free cheeks have their border smooth and only scabrous on its outer edge; they sometimes, as fig. 10, dilate a little in advance of the facial suture. Hypostome (figs. 11 to 15) large, ovate, oblong, very convex, its length one fourth more than the width, but in appearance more; broadest near the base of insertion, from which the central convexity rises immediately and reaches nearly to the tip. A rather narrow ring or rim surrounds the apex and sides, terminating abruptly near the base on each side in what may be called an auricle, followed by a deep notch *c*, above which the ascending processes *a*, *a*, take their origin. The apex of the hypostome is truncate, the corners angular or even mucronate. A distinct sulcus separates the border all round, and within this there is a short oblique furrow on each side. Its whole surface is closely scabrous (fig. 15*); the convex portion has besides scattered larger granules. The organ is hollow when viewed from the inner and under side, and the structure there observable is such as has been often described.* These are two ascending processes, *a*, *a*, rising from the ends of the basal or front margin, and directed obliquely backwards; and on the sides, *b*, *b*, the inflated broadly triangular portions characteristic of the genus. These triangular curved plates give the appearance of thickness on viewing the organ from the side (fig. 12), but the general surface on the inner side is concave, answering to the great convexity of the outer side. Thorax much longer than the head, but narrower, and for most part of it parallel sided, of 11 gently convex rings which are very minutely scabrous; the axis is narrower than the glabella, of nearly equal width all the way down, but scarcely so wide as the pleuræ. These are linear and directed straight outwards for two thirds their length, then curved a little backwards and tapering to a sharp point. The fulcrum, placed at about one third, is of singular structure,—a small semi-oval piece (fig. 8, *a*) is attached to the posterior edge of each pleura, and against this piece abuts a similar tubercle (*b*), placed on the front edge of each, and the two pieces, forming together a narrow oval tubercle, are insulated by a deep sulcus from the body of the pleura, which is also constricted and furrowed across at this point, so as to have the outer and pointed portion (*c*) quite distinctly separated from the small inner one. The latter (*d*) is very strongly divided into two tumid lobes by a short oblique sulcus, and just beyond the constriction the outer portion rises into a stout boss, (fig. 9, *e*) giving the tri-tuberculate form characteristic of the genus.

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* Mem. Geol. Survey, vol. ii. pt. 1. pl. 7.

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* Lovén calls the upper furrow "*frontalis*," and the middle one "*ocularis*," and, though not always strictly correct, it would be a very useful designation. We have employed it above in the diagnosis.

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* M. de Barrande, Neues Jahrbuch (1847), 389, has given a full description of the hypostome of *Cheirurus*. He describes the ascending processes *a*, *a*, (Flügel), as bent upwards at right angles to the surface of the organ, and uniting with the upper crust along the line of the dorsal or axal furrow, with a broad base of attachment, reaching from the upper to the middle glabella furrow. In *Phacops* it has nearly the same position. He also describes a second organ, of the same size and shape, but less convex in all its parts, lying immediately behind the hypostome, between it and the upper crust of the head. This organ he calls *epistoma*; and he has seen it both in *Cheirurus insignis*, and a species of *Phacops*. It has never yet occurred to our observation.

The line of the fulcral points is parallel to the axis for all its length, and the constriction beneath them, though not very marked on the upper crust (fig. 8), produces a longitudinal ridge on the under surface, and a strong furrow in casts (fig. 9). Tail, at least in Dudley specimens, very much narrower than the body, with three strong spinous lateral lobes on each side directed backwards, the outer ones a little divergent and longest; all extend equally backwards,—the tail is therefore truncate—but exclusive of the spines, it is broad triangular, following somewhat the shape of the axis; it is marked on each side by four short deep puncta or furrows, which do not run to the margin in young individuals. The axis is convex and short conical, of three distinct ribs and a small terminal piece —the last very obscurely indicated; there is no mucro between the lowest spines in the ordinary Wenlock forms.

Variations.—The following have been observed. In a Dudley specimen the front or forehead lobe occupies much more than half the length of the glabella, the side lobes being therefore more crowded. In a Dudley specimen, a large tubercle occurs in the middle of the forehead lobe. In some individuals the glabella widens more above, in others it is nearly parallel-sided, and the lateral furrows vary in length. The head spines occasionally reach the third thorax segment. The margin of the cheek in one specimen is notched at the facial suture (fig. 10, *a*). The axis of the thorax is, sometimes, though rarely, as wide as the pleuræ. The most important variations occur in the tail,—in fig. 5, we have represented the spines as all directed backwards, and the two central ones closely approximate; they are so in the large Ledbury specimen figured in the "Silurian System," where too they are shorter than the outer spines. In fig. 6, they are a little space apart; in a Lower Silurian specimen we have seen a small tubercle appear between, and in our var. β a decided, though short, mucro protrudes. Lastly, as a monstrous variety from the Silurian rocks of Kildare,—we have reason to think it of the same species,—we have one with a wider interval, and a bifid mucro. In old specimens, as well as in var. β, the spines diverge much more than in those we have here figured. Perhaps some of these variations are due to sex.

Affinities.—The considerable variations above mentioned lead us to believe that the *Ch. insignis*, Beyrich, may be but a variety of this species. We have not materials enough to justify our recording it as a variety, as Beyrich describes and figures it as with a much wider glabella, the furrows reaching but a short way across. The hypostome is very similar, and the tail differs very little, except in the much greater central mucro and more divergent spines, towards which characters we have shown considerable approaches in some of our varieties. It was these close resemblances which induced us to say, in the volume already alluded to, that our British species occurred in Bohemia with the *C. insignis*. But I find the Bohemian specimens do not show any tendency to vary towards ours.

Barrande, in his great work which has just been published, figures a fine new species, *C. Quenstedti*, closely allied to both the above, but the head spines are very much longer and slenderer, and so are those of the tail; the glabella too is parallel-sided, its furrows run quite across, and the lower pair of lobes nearly meet. *Calym. ornata* of Dalman, since fully described by Lovén, must be very nearly like our species; but the greatly elongated first pair of spines to the tail, and the parallel-sided glabella must separate it for the present; we subjoin a note giving a few of its prominent characters.* *Ch. obtusicaudatus*, Corda, is another nearly allied fossil.

History.—The history of the species dates clearly, we think, from Hisinger's Lethæa Suecica, where the head of a large specimen is figured, and the species considered identical with the *Calymene speciosa* of Dalman, found by Nillson in the isle of Œland. There is, however, some doubt of the correctness of this reference. Dalman described in a supplementary note to his "Palæadæ" two species, *C. speciosa* and *C. clavifrons*, comparing the former with the *Trilobites Sternbergii*.† This comparison sufficiently indicates that a large species, with the glabella broad in front, must have been intended; and we lay the more stress on this, because it proves that the species with a small oval glabella, narrowed in front, which was figured by M. Sars in Oken's Isis, 1835, as *C. speciosa* of Dalman, is not that species, and could never have suggested the comparison above mentioned. We believe it was this erroneous reference by Sars, joined to Dalman's rather loose description, "smooth, large, oval, and convex glabella," which has thrown doubt on the identity of his species with Hisinger's figure. But since there are several species of the genus found in Norway and Sweden, as indicated by the figures of M. Sars, above quoted, and those lately given by

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* Glabella æquilata; abdomen articulis 3, basi connatis; primo secundum longè superante, in appendicem crassam teretem longissimam utrinque producto; secundo tertium excedente, hoc verisimiliter brevissimo. Loc. Husbyfjol, Ostrogothia. Lovén in Ofversigt Vetenskaps Akad. (1844), p. 64.

† Sternberg, Verhandl. Vaterlands, Mus. Prag. 11th pt., p. 45. tab. 13 *a*. Dalman says, that in his species "the glabella lobes are all connected down the middle, while in Sternberg's they are separated by transverse furrows."

Angelin in the "Palæontologia Suecica," we prefer with Dr. Beyrich,* to leave the question undecided, and wait for the descriptions and references now in course of publication by M. Angelin.

Sir R. I. Murchison first published it in this country, referring it to Paradoxides, as the only genus then published which it appeared to resemble, especially as he regarded the two lower prongs only as constituting the tail; he also figured the body rings, and commented on their remarkable rough sculpture; this figure of the body is accidentally reversed upon the plate, the portion nearest the head being turned downwards.

It is next mentioned by Lovén in 1844, describing two of Dalman's species, the *C. clavifrons*, and *C. ornata*, and to the latter he referred the figures given by Murchison of the present species. But the comparison could be made only with the body segments, and these are far too much alike in different species. The description too of the head given by Lovén, though agreeing in the main with the perfect examples we now possess, is not sufficiently precise, and we are not therefore justified in reuniting ours with *C. ornata*, more especially so, as the excellent figure of that species lately given by Angelin, Pal. Suecica, p. 21, fig. 1, represents the uppermost or forehead lobe of the glabella as not wider than the rest, ("equilata glabella," Dalm.), or occupying nearly so much space in length as in our species.

It is to be regretted that to these descriptions, the author has not added that of *C. speciosa;* he does not even mention this disputed species. In 1845, Dr. Beyrich first described the entire animals of this genus, and introduced the British fossil as an undoubted species of *Cheirurus*, leaving for future observation its identity or otherwise with his *C. insignis*, to which, as above stated, it bears great resemblance.

It was again published in the second volume of the Memoirs Geological Survey, 1848, where the head of the species was described and identified with *Calymene speciosa* of Hisinger. And we still regard Hisinger's excellent figure as a proof that our species is found in Gottland, in a stratum marvellously like our own Wenlock limestone. In that notice the very large size the species attained was represented, and we accidentally repeated the error of reversing the position of the body ring by turning the front edge downwards. Lastly, Professor M'Coy, in one of his useful contributions to the "Annals of Natural History," described the entire animal, which he has since figured in the Synopsis of the Woodw. Mus. fossils, retaining the generic name *Ceraurus*. We had previously selected this beautiful example from the collection of Mr. Williams, who found it near Llandovery, and we have since again examined it. It is much elongated and narrowed upon the cleavage of the rock, but is identical with the present species, and is very interesting as showing that the Lower Silurian form is somewhat intermediate, as regards the tail, between the ordinary Dudley form and our var. β, for the lower prongs are but slightly distant, and have but a tubercle, instead of a prominent mucro between them.

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* Untersuch. über einige Böhm. Trilob. (1845), 1st part, 1. p. 17, 18.

Barrande's exquisite figures of the genus, fortunately now before us, show the structure of all parts of the body completely. He has figured the hypostome in several species; we are fortunate in here being able to add the under side of that organ, and the structure of the eye.

British Localities and Geological Range.—LLANDEILO FLAGS to AYMESTRY LIMESTONE.—In Llandeilo flags; Sholes Hook, and Pelcombe Cross, Robeston Wathen, and Llandowror, near Haverfordwest; Goleugoed, Llandovery, (Cambridge Museum). In Bala limestone; Rhiwlas and other localities, near Bala, North Wales; Chair of Kildare, Ireland. In Lower Silurian rocks, at Mullock, Girvan, Ayrshire, (Coll. Sir R. I. M.) In Woolhope limestone; Nash Scar, Presteign, (Coll. Mr. Davis.) In Wenlock limestone; Haven, near Aymestry, (Coll. Rev. T. T. Lewis); Brand Lodge, Malverns; Dudley; Dormington Wood, Woolhope. In Aymestry limestone; Downton Castle, Ludlow.

Var. β.—In Wenlock strata; Nelson's Tower Wood, east of Carmarthen.

Foreign Distribution.—Gothland, in Upper Silurian (HISINGER); (Œland, Lower Silurian, DALMAN ?).

EXPLANATION OF PLATE II.

Fig. 1. Specimen, perfect except the tail, from Haven, near Aymestry; in the collection of the Rev. T. T. Lewis, of Bridstow, Ross.

Fig. 1*. Head of same, dissected, showing the granulate glabella, *a*, and deeply pitted cheeks, *b*, *c*. (the eye is raised too much.)

Fig. 2. From Dudley, collection of J. Gray, Esq. A fine half coiled specimen, showing the whole 11 rings, and the small tail.

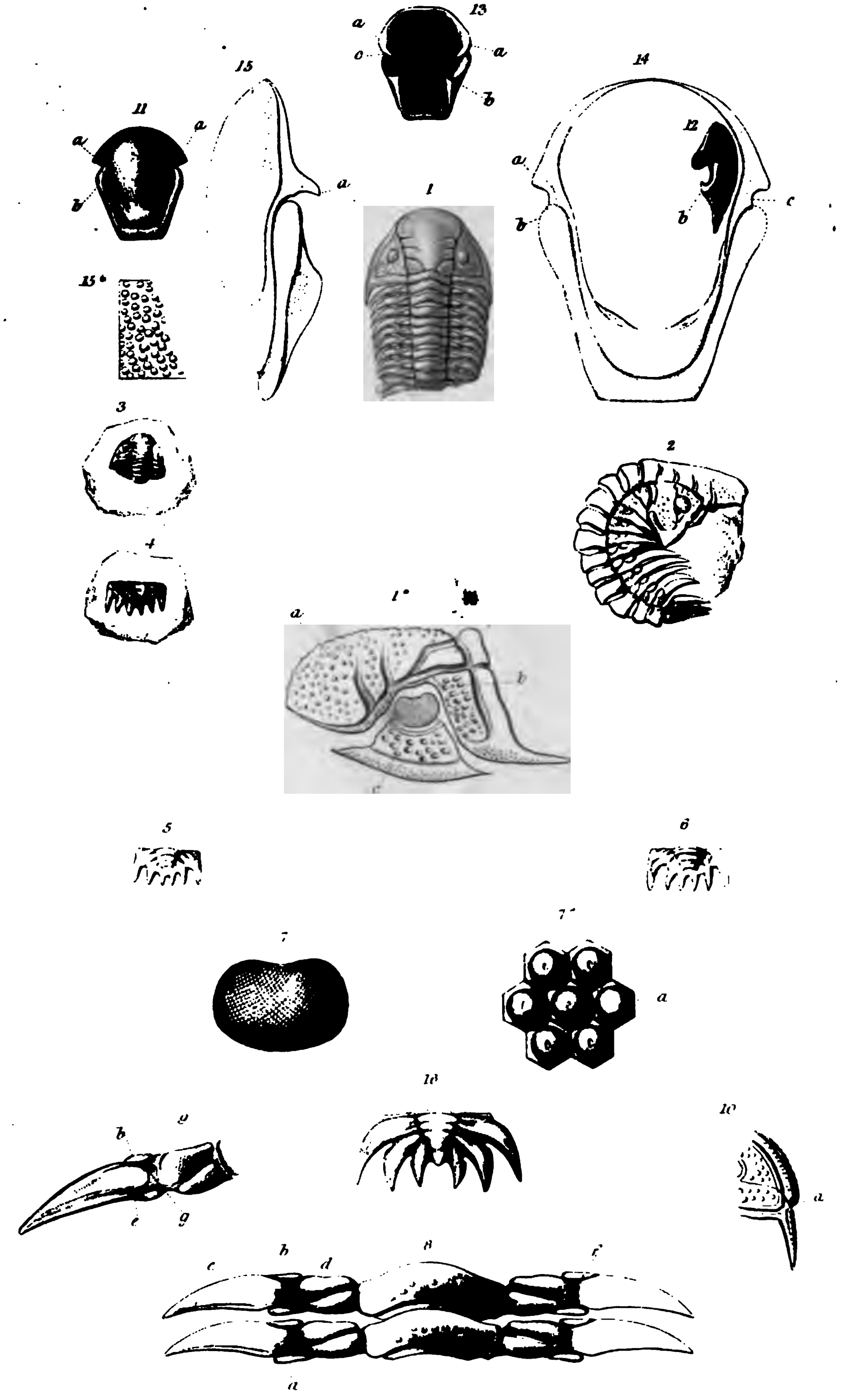
Fig. 3. Same locality and collection. Very young coiled specimen.

Fig. 4. Same locality and collection; showing the under side and incurved edge of the tail, with the spines a little more apart.

Fig. 5. Tail of young specimen, from Dudley; collection of T. W. Fletcher, Esq. It has the posterior spines approximate.

Fig. 6. Same locality; collection of J. Gray.

(Silurian.



CHEIRURUS BIMUCRONATUS _ *Murchison.*

Fig. 7. Eye, magnified.

Fig. 7*. Do., still more highly magnified; the facets are convex; and at *a*, one is in its original condition; the pits on the others are due to wear.

Fig. 8. Two thorax joints of Aymestry specimen (fig. 1); at *a* and *b*, the curious tubercles at the fulcral point are seen; *c*, is the outer spinose portion; *d*, the inner bilobed part; they are separated by a furrow, *f*.

Fig. 9. Specimen from Nash Scar, Presteign, collection of J. E. Davis, Esq. This is an internal cast, and shows the outer tubercle *e*, and the furrow *g*, more strongly than in fig. 8, which has the crust on.

Fig. 10. Under view of cheek from the same specimen (as fig. 9); it has an unusual swelling above the facial suture *a*.

Fig. 11. Perfect hypostome (collection Geol. Surv.), from Dormington Wood, Woolhope; *a*, the lateral ascending processes; *b*, the marginal wings.

Fig. 12. Side view of do.; the incurved triangular plates are shown at *b*, the lateral notch at *c*.

Fig. 13. Under view; *a*, *a*, the "ascending processes," which are attached to the under surface of the glabella at its sides; *b*, *b*, the incurved triangular lateral plates, possibly for the attachment of muscles; *c*, the hollow space under the ascending processes, answering to the lateral notch in fig. 12.

Fig. 14. Outline of the largest hypostome we have seen, from the Lower Silurian limestone of Kildare, Ireland; the letters are the same as in fig. 11.

Fig. 15. Lateral view of the same.

Fig. 16. Var. β, *centralis*, from the Wenlock strata of Nelson's Tower Wood, Llandeilo.

Remarks on the Genus.

It seems necessary to contend for the generic name adopted here, because a rigid adherence to priority would compel us to relinquish a name now familiar to naturalists, and bestowed by Beyrich on a group which he had carefully investigated and fully described. Now that Hall has given such excellent figures of *Ceraurus*, we know perfectly well what was meant by the obscure and imperfect plaster cast published by Green under that name. But the original description was scarcely more than sufficient to indicate that it was a trilobite, and consequently it has been referred with doubt to various genera by Bœck, Beyrich, Lovén, Portlock, and Burmeister. A genus so ill constructed and imperfectly described, can have no authority; and it would be unjust to substitute such names for those given by the first real describers. The same rule we think fully justifies us in rejecting *Zethus* of Pander, a name lately revived by Dr. Volborth*; for the genus as constituted by Pander consists of two species, to either of which the meagre and incorrect description will apply; the first of these being, by Dr. Volborth's own admission, a species of *Cheirurus*, the second a *Cybele*. He would restrict the name to the latter; but custom and the opinion of naturalists in general would point in doubtful cases like this to the first as the typical species, and we should then have to apply *Zethus* to all we now call *Cheirurus*; more especially as it was the *Cheirurus* only of which Pander knew the entire body. He describes it as having 16 ribs in thorax and tail together, the segments of the tail being free like those of the thorax; this is untrue for either genus; and he denies any trace of eyes. Of the *Cybele*, a fragment only is figured, and Pander even doubts whether it belongs to the genus, so that he evidently intended the first for his type; and had either his figure or description been intelligible, or had he referred to Sternberg's or Dalman's species as cognate, his name ought to have been retained. But we believe the right of priority of name, rather than that of description, cannot with advantage be so rigidly enforced, and we accept *Cheirurus* as the first intelligible description, as well as the clear definition of a remarkable group. With regard to the affinities of the genus, we have come, as above stated, to the conclusion that it must be considered nearly related to *Phacops*. Barrande, in his ingenious and simple arrangement of the groups lately published,* places *Cheirurus* among the series which he defines as having the "plèvre à bourrelet;" and certainly it is most closely allied to some genera, *Spherexochus*, *Cybele*, &c., which possess this character. But an inspection of our plate will show that the characteristic furrow ("sillon") of the pleuræ is only shortened, not absent in this genus. In several Bohemian species it is quite evident, and in the *Cheirurus claviger*, which Corda elevates to the rank of a genus, the furrow continues along the whole length, as it does in most trilobites; and we may state generally, that we believe this character to be merely a special modification, since all pleuræ have the furrow, either bisecting them as in the ordinary form, or so near the anterior edge as only to separate a mere line for the front or fulcral portion.† In *Sphærexochus*, the nearest ally of the genus we are considering, it is not, perhaps, indicated at all. We think, therefore, that the other characters which we regard as of more importance, viz. the structure of the eyes, and the course of the facial suture, will connect *Cheirurus* with *Phacops*. But with respect to the limits of the genus, we are strongly inclined to think *Sphærexochus* ought not to be separated from it, since such species as *Ch. clavifrons* of Dalman, and *Ch. globosus* of Barrande seem exactly intermediate, having the head of *Sphærexochus* and the tail of *Cheirurus*. However, if we allow the striking character of the thorax rings to guide us, we shall find it agree with the habit in marking out three distinct genera already recognized, viz.—

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* Transactions of the Royal Mineralogical Society of Petersburgh (1847.)

Eccoptochile. Corda. Cheeks scrobiculate; pleuræ 12, furrowed; hypostome with lateral furrows:

Cheirurus. Beyrich. Cheeks scrobiculate; pleuræ 11, nodulated; hypostome with lateral furrows:

Sphærexochus. Beyrich. Cheeks not scrobiculate; pleuræ 11, simple, rounded; hypostome without lateral furrows:

And the species which have globose glabella, but still have the 11 nodular pleuræ, will remain in *Cheirurus*, not in *Sphærexochus*, just as we find this variation in the glabella of *Phacops*, while the characters of the thorax remain the same.

The genus is Silurian and Devonian; it does not rise into the Mountain Limestone.

Other British species of CHEIRURUS.

SECTION CROTALOCEPHALUS.

Glabella furrows continuous across, all strong and distinct.

1. *C. articulatus*? [*Calym. articulata*, Münst. Beitr. Heft, 3. pl. 5. fig. 7?] *Ch. Sternbergii* (Münst), PHILLIPS, Pal. Foss., fig. 247.

I do not venture to characterize this species from the imperfect fragments we possess. The glabella is long, narrow, and scarcely clavate forwards, and not very convex. The upper and middle glabella furrows are very strong, and go right across, and the basal lobes are narrow, triangular, transverse, and they nearly meet in the middle of the glabella, leaving but a small space between.

The latter character I suspect to have been much exaggerated by Münster, in the figure above quoted, who has represented the basal lobes as forming one transverse piece. Our rare British fossil is certainly more like this figure than the *C. Sternbergii* of the same author, in which the furrows are partially obliterated in the middle, and the glabella is broader.

Locality.—Barton, S. Devon (Phillips); Newton Bushell, in Devonian limestone. Presented by R. A. C. Austen, Esq.

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* Système Silurien de la Bohême, 1853. Also Ann. and Mag. Nat. History, Sept. 1850.

† This narrow line may certainly be seen in *Acidaspis* and *Cybele*; in *Bronteus* it seems to have completely vanished.

SECTION CHEIRURUS proper.

Glabella with the furrows all distinct, but not meeting across.

2. *Ch. speciosus.* Dalm. sp.—above described.

3. *Ch. gelasinosus*, Portlock. *Amphion gelas.* id. Geol. Rep., t. 3. fig. 4. (head); and *Arges planospinosus*, pl. 5. fig. 9. (tail). *Cheirurus*, BEYRICH (1845), Böhm. Tril., 1. p. 19. Salter (1851), Quart. Geol. Journ., vol. vii. pl. 8. fig. 1. *Cheirurus planispinosus*, Bronn. Ind. Pal. (1848).

Ch. depressus, capite transverso, glabellâ rectangulari sulcis brevibus transversis, lobo frontali brevi, basalibus oblongis transversis vix circumscriptis, uno ab altero spatio æquali sejuncto; genis latis, marginibus depressis, spinis brevibus; caudâ (hic haud dubie refertâ) latâ, segmentis utrinque tribus latis, ad basin longe adnatis, acuminatis; primo in appendicem longam producto secundum longe excedente, hoc tertium brevem superante; axi 4-annulato, articulo ultimo minimo angusto, nec apicem caudæ profundè emarginatum attingente.

The upper lobe of the glabella is not at all broader—sometimes it is narrower—than the rest; and in the furrow beside it there is a very deep indentation. On the under side of the crust this would be a strong ridge, to which, as Barrande has shown, the processes of the hypostome are attached. The transverse form of the head, especially the wide cheeks, easily distinguish this from any other species. The surface of the glabella is smooth, or nearly so.

There can be little doubt that, as Beyrich has suggested, the head and tail belong to one animal. They are alike broad and depressed, and agree in size, while no other species of the genus occurs with them.

Locality.—Co. Tyrone, head and tail; limestone of Ayrshire, head only. [Presented by Mr. C. Moore.]

4. *Ch. cancrurus.* sp. n.—*Ch. satis magnus, caudâ lineas* 20 *latâ transversâ, apice abruptè truncato præmorso; axi lato, annulis quatuor subæqualibus, tertio à quarto punctis binis remotis solum separato; lateribus spinis quatuor longis sub-parallelis, ad basin adnatis, transversis, apicibus lente decurvatis; basalibus utriusque lateris longo intervallo remotis.*

A most remarkable species, in which the four lateral lobes of the tail start horizontally from the broad axis, instead of gradually converging beneath it, and leave its apex bare; the breadth of this space being increased by the outward direction of the spines themselves, which begin to curve downwards only when when they have attained half their length. The appearance of the perfect tail is just like that of a crab; *præmorsus* might have been an appropriate specific name. *C. obtusatus*, a Bohemian species, somewhat resembles this, but the spines are radiating, not parallel.

There is a rare cephalic shield in the Chair of Kildare limestone, which may very probably belong to this species; it is as unusual in its character as the tail we have described. It is the *Ch. gelasinosus* of M'Coy's Synopsis Sil. Foss. Ireland, 44. The cheeks are scrobiculate, and the eyes forward, the glabella smooth, clavate, long, and narrow; the neck furrow trends upwards towards the middle on each side; the basal furrows curve downward, but do not meet the neck furrow, or quite circumscribe the subtriangular basal lobes; the middle furrows are strong and transverse, the upper pair apparently obsolete (probably some faint traces of them may be found.) But there is enough to distinguish the species as a very curious one, and provisionally I refer it to the *C. cancrurus*, with which it agrees well in size.

Locality.—Limestone of the Chair of Kildare in Ireland. [tail in Survey coll.; supposed head in the cabinet of Mr. R. Griffith.]

5. *C. octolobatus.* M'Coy's Synopsis Pal. Foss. Woodw. Mus., t. 1 G. f. 10. [Mem. Geol. Surv., vol. ii. pt. 1. pl. 7. fig. 36, without name.]

C. pygidio transverso elliptico semiunciali, bis quam longo latiori, margine octolobato; axi depresso, annulis tribus, duobus superioribus subæqualibus, tertio lato a limbo terminali punctis *binis solum distincto, lateribus planis, lobis anticis curvatis et distinctis, reliquis ad basin connatis, apicibus ovatis.*

Locality.—Bala limestone; Bala, frequent; Hendre wen, Cerrig-y-druidion, Denbighshire.

Section Actinopeltis. Corda.

Glabella inflated, the upper lobes indistinct.

6. *Ch. clavifrons*, Dalm. sp.? [*Calymene*, Dalman, Palæad. 59. not of Hisinger. Lovén Ofv. Kongl. Vetensk. Akad. (1844), 63, 64?] *Sphærexochus juvenis*, Salter (June 1848), Mem. G. Surv. vol. ii. pt. 1. pl. 7. fig. 1–3 (exclude 3 *b*). *S. clavifrons*, ib. Errata, p. viii. *Cheirurus clavifrons*, in Appendix, Pal. Foss. Woodw. Mus., t. 1 F. fig. 11, and 1 G. fig. 9. *Ceraurus*, M'Coy, ib. 154 (1851.)

C. capite sesquiunciali semi-elliptico, in juveni rotundiore, convexissimo; glabellâ maximâ ovali gibbâ, genis latiore, granulosâ; sulcis duobus anticis brevibus obscuris, basali profundo fere ad cervicalem decurvato lobumque subovatum ambiente; genis declivibus scrobiculatis brevi-spinosis; caudâ axi longo, 4-annulato, articulo ultimo rotundo, lateribus utrinque trispinosis, spinis valde inæqualibus vix basi connatis, primo ad basin lato, brevisulcato, secundum longe superante, hôc integro angusto tertium brevem sæpe obsoletum multo excedente; spinis omnibus retrorsis subparallelis.

The glabella, when perfect, shows small regular granules or tubercles widely scattered all over it. The punctations too on the cheeks are rather small, and scattered. The terminal spines of the tail in some specimens are very short and obtuse, and the whole tail is in some shorter and broader than in others, even from the same locality, and the spines consequently more divergent at their bases.

There are some points of difference between our fossil and that which Lovén has carefully described from Dalman's original specimen and we may have again to recur to the name *juvenis* as above quoted. The Swedish species is described as having long straight head spines, the glabella nearly as wide as the cheeks. Ours, now that we have more perfect specimens of the head and caudal shield from Ireland, shows short head spines, and the inflated glabella is certainly wider than the cheeks. In all other respects Lovén's description applies well. By the description also of the tail of the *C. ornatus*, Dalm., given by the same author with the above, it would appear that this species had a caudal shield precisely similar to that of ours.

Localities.—Llandeilo and Bala rocks; in South Wales, Sholes Hook, Haverfordwest. In North Wales, Bala, abundant; Cader Dinmael, Denbighshire; near Llanfyllin, Montgomeryshire—in Upper Bala beds; in Westmoreland, Applethwaite Common; in Ireland, Chair of Kildare,—frequent, and of large size.

J. W. Salter.

August, 1853.

BRITISH FOSSILS.

DECADE VII. PLATE III.

SPHÆREXOCHUS MIRUS.

[Genus SPHÆREXOCHUS. BEYRICH. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palædæ.) Eyes facetted? "Head very convex, the cheeks not scrobiculate; facial suture ending on the external margin near the angles, in front continuous and submarginal; glabella large and nearly spherical, with three furrows on each side, the two upper very obscure, the lower strong and curved down to the neck furrow; thorax of 11 joints, without any furrows; tail of 3 segments, free at their ends;" hypostome subtrigonal, with a marginal furrow, but without lateral furrows. No rostral shield.]

DIAGNOSIS. *S. granulosus; "glabellâ lobis infimis profunde circumcinctis, paullum tumidis,—spatio interjecto diametrum eorum superante; caudâ pleuris tumidis."*

SYNONYMS. *Calymene clavifrons*, HISINGER (1840), Leth. Suec., Supp. 2d. t. 37. fig. 1 (not of Dalman.) *Sphærexochus mirus*, BEYRICH (1845), über einige Böhm. Tril., p. 21. *S. mirus*, ibid., Zweite Stück (1846), t. 1. fig. 8. *S. calvus*, M'COY (1846), Syn. Sil. Foss. Ireland, pl. 4. fig. 10. *S. mirus*, CORDA (1847), Prodrom. einer Monog. Böhm. Tril., fig. 72. BARRANDE (1853), Syst. Sil. de Bohême, vol. i. pl. 42. fig. 11–18.

We are indebted to Mr. John Gray for the fine Dudley specimens which figure in this plate, and to Mr. Fletcher for those from which the details are drawn. Fragments and detached heads are not uncommon; but these are the only perfect British specimens we are acquainted with. The species is cosmopolitan, at least it ranges from Bohemia to the Western States of America, and in our own country is found both in Upper and Lower Silurian rocks.

Description.—The animal is capable of rolling itself into a complete ball, of which the large head forms a very conspicuous part. The general form is oblong; the length of English specimens usually about an inch and a half, and the breadth ten lines; they never appear to reach the length of two inches.

The head is more than one third the whole length, and the glabella is very large, occupying, as seen from above, four fifths of the width, and quite overhanging the narrow front margin. It is, excluding the neck segment, nearly a true hemisphere, and has a pair of large orbicular lobes at the base, deeply circumscribed, and further apart from each other than their own diameter. The furrow that bounds each of these lobes is broad, sharp, and equal in depth all round, leaving no communication with the body of the glabella (fig. 3, *a*, 11 *a*). Above these lobes on each side are two faint impressed lines which represent the upper furrows (in fig. 4); of these (*a*) the one next to the round basal lobe is placed at a less distance from it than the diameter of that lobe, at about the point of the head's greatest width, and the upper one (*b*) at an equal distance in advance of it towards the front. The cheeks are small in comparison with the glabella, and hang vertically from its sides (fig. 4, *cc*), like a pair of lappets from a cap or helmet; they are oblong and have a thickened margin. The small convex eye is placed very near the glabella, and below the middle of the head; the facial suture runs from it outwards, and reaches the exterior margin which it cuts obliquely a little in front of the posterior angle, as at fig. 3, *c*; in front of the eye it continues parallel to the glabella, and runs along the edge of the narrow front margin, leaving the free cheeks connected beneath by a narrow band (fig. 4, *d*). Each free cheek is hatchet-shaped, and the small eye (fig. 5, *a*) occupies the inner corner, supported on a fold of the crust, *b*, which truncates, or even indents it below. The eye is thus pushed up into a supine position; it is short, oblong, and very convex. The lenses are numerous, larger in size than the granulations of the general surface, and placed near together, less than half their diameter apart. In this specimen we have not the outer surface sufficiently perfect to enable us to say whether the cornea is raised into facets (as Barrande thinks) or not; the surface is therefore left blank (fig. 6, *a*); from the inferior surface, *b*, the lenses have fallen out, leaving pits which indicate their size. The posterior corners of the head are rounded off and contracted to a less width than the free cheeks, and they bear instead of a spine, only a small tubercle (fig. 3, *d*), which is placed far inwards.

The hypostome has not yet been found in England, but it is figured in M. de Barrande's* plates. It is subtrigonal, straight at the base, where it is much broader than it is long, and the apex is rounded and slightly emarginate. A broad shallow furrow runs round the end and sides, leaving only a small central convexity of the same shape as the hypostome; this convexity is not indented by any lateral furrows.

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* If this figure be as complete as M. de Barrande's figures usually are, there is no lateral notch nor any visible ascending processes. M. Corda's figure, however, exhibits a narrow rim at the base, with a small lateral process on each side. The notch would then exist between the lateral border or wing (flügel), and these small processes and the resemblance to *Cheirurus*, in other respects so closely allied, would be more complete.

The surface of the head is covered by a fine close granulation (fig. 11), which occupies also the free cheeks or wings (fig. 5); it is therefore one of the generic distinctions from *Cheirurus*, in which the cheeks are always pitted or scrobiculate.

Thorax parallel sided, scarcely tapering backwards, of 11 thick rounded rings; the axis as wide as the sides, and of equal breadth throughout, very convex; each joint much raised and rounded (see fig. 10). Pleuræ horizontal as far as the fulcrum (fig. 7, *a*), and then abruptly deflexed, and from this point the pleura tapers outwards to a conical blunt point, which at the extreme tip is a little bent forwards. The fulcrum is placed at rather less than half-way from the axis, but in the last segment (fig. 8) it approaches much nearer,—to about one third. Its place is indicated by a protuberance both on the forward and hinder edge of each segment (fig. 7, *a* and *b*), but these swellings are not isolated tubercles as in *Cheirurus*, nor are there any oblique or longitudinal furrows on the pleuræ, as in that genus, to break up the uniform convex surface of the segment.

Tail about semicircular, truncate; the axis conical, its base of two depressed close-set rings, its apex of one long triangular joint, which is separated from the second joint by a deep depression; from thence it is flattened, or even depressed for some distance, but suddenly rises to an obtuse and elevated tip (fig. 9, *a*); which, seen sideways, presents the appearance represented in fig. 2, where *a* is the obtuse tip of the axis. The sides are composed of three obtuse convex lobes which scarcely project on the margin; the upper one follows the bend of the hindermost pleura, the second is less curved, the third parallel to the axis; all are deflected so that an end view ot the tail (fig. 13) presents an angular figure.

The entire surface of the thorax (fig. 10) and tail, like that of the head, is covered with a fine granulation, the grains of equal size throughout.

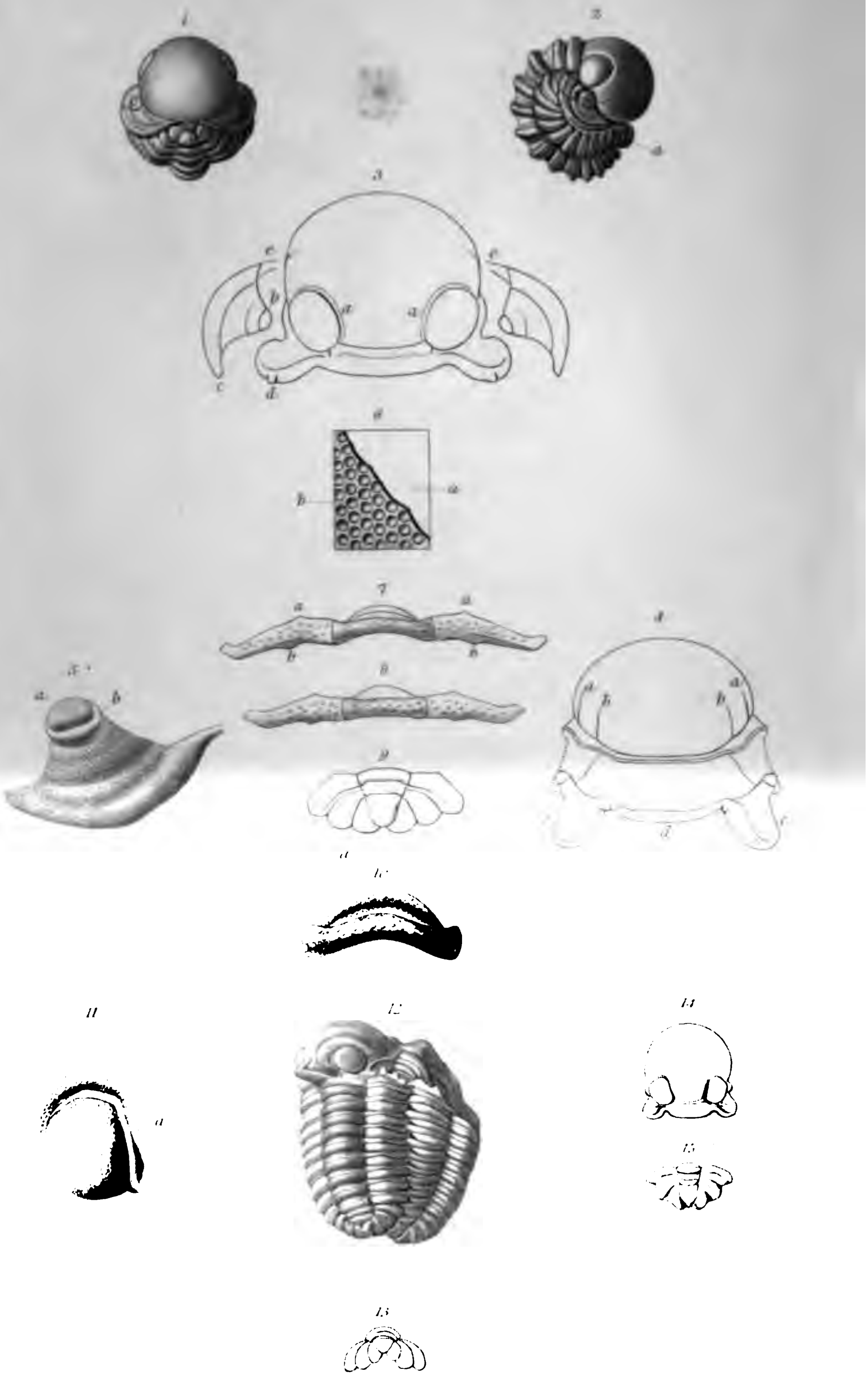
Variations.—Our Dudley specimens have the tail somewhat shorter and wider, and the terminal joint of the axis therefore shorter, than those from Bohemia. Irish specimens (figs. 14, 15) are more like the foreign ones in this respect. The space between the lower glabella lobes is least in these Irish specimens, though some of them have it consideraby wider than the diameter of the lobes; in a Wexford specimen, the space is proportionally as wide as in those from Dudley, which often have the lobes as far apart as in Bohemian examples.

Affinities.—But one species, and of that only a caudal shield, has been described, which at all closely resembles this,—we allude to a species published without name by Dr. Beyrich, from Gottland, in his second paper (1846, pl. 1. fig. 9); it has the side lobes of the tail lengthened out into spines of some length. The terminal joint of the axis too is shorter. There is a second species in Britain, found at Haverfordwest, to which if it were perfect enough, a new name might be applied. It differs from *S. mirus* in this respect, that the large basal lobes of the glabella are more really tumid, especially outwards, less than their diameter apart, and connected with the body of the glabella by a narrow depressed neck on the inner side, the boundary furrow not comnot completely circumscribing the lobe as in our species. But only a fragment of the head has yet been found, and I may say, that it is singularly like a fragment apparently of this genus lately discovered by Captain Strachey in the Silurian rocks of Tibet. There is a species figured by Sars in Oken's Isis, 1835, tab. 9. fig. 8, as the *Cal. clavifrons* of Dalman, which has a nearly globose glabella with the basal lobes very small; but it is probably a *Cheirurus*, and would, we think, be found to possess punctured cheeks.

History.—That Hisinger's figure of *Calym. clavifrons* does not represent the species so described by Dalman, though very probably, as Beyrich suggests, it may have been associated under the same name in his collection, has been shown by every author who has since written on the subject; and the great similarity between it and the species we are describing must be evident to all. Dr. Beyrich supposes it may be the head of the other species we have mentioned above from Gottland; but, as Hisinger's specimen came from Furudal in Dalecarlia, this is not certain, and we think we cannot be wrong in referring it to the present cosmopolitan species, of which it is a very good representation. Dr. Beyrich, when he formed the genus in 1845, had only the head and caudal shield, but these were sufficient to show him the generic distinctions, which we think are now confirmed by characters drawn from the hypostome and thorax rings, since figured by M. Corda and Barrande.

Professor M'Coy next described the head from Irish specimens, considering it a distinct species from the Bohemian one, but identical with that of Hisinger. His description is very clear, but having found among the Irish specimens considerable variation in the point he marks out as distinctive, viz., the breadth between the lower

gical Survey of the United Kingdom. SPHÆREXOCHU
(Silurian.)



SPHÆREXOCHUS MIRUS *Beyrich.*

lobes of the glabella, we have here ventured to unite them ;—the species agrees in all other essential characters. M. Corda in his Prodromus, 1847, next figured an outline of the entire animal and its hypostome, and Barrande's accurate figures complete the illustrations of this trilobite.

British Localities and Geological Range.—LLANDEILO FLAGS to WENLOCK LIMESTONE. In Lower Silurian, Chair of Kildare, county of Kildare, Ireland; and in beds of the same age, Carrickadaggan, county of Wexford. In Wenlock strata, Dudley Castle Hill; Trindle near Dudley; Walsall (Survey Coll.)

Foreign Distribution.—In Bohemia; Komorau, Hills of Listice, Kolednik, &c., in Etage E, Upper Silurian, and also in one of the "*colonies*" in the Lower Silurian, Etage D, (BARRANDE). In Sweden, Furudal, Dalecarlia; in Lower Silurian (HISINGER). In North America, Springfield, Ohio, Upper Silurian. (De Verneuil and Sir C. Lyell.)

EXPLANATION OF PLATE III.

Fig. 1. Coiled specimen from Dudley; Mr. John Gray's collection.

Fig. 2. The same specimen viewed sideways; *a*, the terminal boss of the axis of the tail.

Fig. 3. The head, dissected; *a*, *a*, the strong basal glabella furrows; *b*, the small eye; *c*, termination of the facial suture in front of the posterior rounded angles; *d*, the rudimentary cheek spine; *e*, *e*, connecting portions of the free cheeks.

Fig. 4. Front view of ditto; *a*, is the middle glabella furrow; *b*, the anterior one; *c*, *c*, the free cheeks; *d*, the connecting portion, here separated from the glabella along the line of the facial suture; the dotted lines at *b* indicate the natural position in this view of the fixed cheeks, which are much bent down.

Fig. 5. Free cheek, with the supine eye (*a*) actached; *b*, the fold of the crust which supports the eye, the "*palpebra inferior*" of some authors; the surface of the cheek granulated equally all over.

Fig. 6. Magnified portion of the eye; *a*, upper surface, obscure in these specimens, but probably facetted; *b*, lower suface, the lenses fallen out.

(Figs. 3 to 6 also from Mr. Gray's collection).

Fig. 7. Third or fourth thorax ring; at *a*, the fulcrum, and *b*, the prominence against which the fulcrum of the succeeding segment abuts.

Fig. 8. Last thorax segment, the fulcrum near the axis. In this and the preceding figure the pleuræ are represented as flattened out to show their characters; they would appear much shorter on viewing them from above.

Fig. 9. Tail; at *a* the prominent tip of the axis is shown.

Fig. 10. Part of thorax joint; *a*, the axis magnified.

Fig. 11. Basal lobes of the glabella, magnified to show the fine granulation that covers the whole head; *a*, the deep circumscribing furrow.

(Figs. 7 to 11 are taken from Mr. Fletcher's specimens, Dudley).

Fig. 12. A group from Dudley, Mr. J. Gray's collection.

Fig. 13. End view of the tail.

Fig. 14. Head, from the limestone of Kildare; it is a little elongated by pressure. Other specimens show a rounder form. [Survey collections.]

Fig. 15. Tail, more elongated than in the Dudley specimens, also from Kildare.

Remarks on the Genus.

When originally described by Beyrich, in 1845, he naturally included in this genus the species of *Cheirurus* with an inflated glabella, in which the anterior furrows are nearly obsolete, such as *C. sphæricus* of Esmark (which Sars described and figured as the *C. clavifrons*, Dalm.), and the true *C. clavifrons*, of which Lovén has since given so excellent a description. But the latter species has the nodular and furrowed thorax rings, spinose cheeks, and the long spined tail, characteristic of *Cheirurus*, so much so, that Dr. Beyrich asserts that portions of separate trilobites must have been combined in the description. We have, however, in England, as above described under Plate 2, the same or a very closely allied species, showing these characters, which we formerly described as *Sphærexochus*, but now consider a true *Cheirurus*. The *Cheirurus globosus* of Barrande, and the *C.* (*Actinopeltis*) *Caroli Alexandri* of Corda, are examples of this section, to which for convenience sake, the sub-generic term *Actinopeltis* might be applied. [See *Cheirurus*, ante.]

J. W. SALTER.

August, 1853.

BRITISH FOSSILS.

DECADE VII. PLATE IV.

ENCRINURUS SEXCOSTATUS. Figs. 1 to 11.

[Genus ENCRINURUS. EMMRICH. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Glabella inflated, clavate, with 3 indistinct lateral lobes, and a large forehead lobe; eyes pedunculate, smooth (finely facetted, Kutörga); the facial suture posteriorly ends in advance of the head angles, and in front runs above the margin; the cheeks are separated in front by a vertical suture, enclosing a narrow vertical rostral shield; thorax segments 11, equal, without pleural grooves, notched at the ends, but not produced into spines; tail with the ends of the pleuræ free, the axis many ringed. *Eνκρινος* a lily-shaped animal; *ουρα* a tail, in allusion to the resemblance between the many-jointed axis of the tail and the stems of the Crinoidea.]

DIAGNOSIS. *E. latus; glabellâ anticè subsphericâ et ad marginem frontalem fasciâ latâ crassâ circumcinctâ; genis scrobiculatis, angulis spinosis; caudâ trigonâ, obtusâ, axi annulis crebris, per medium (nonnullis anticis exceptis) obliteratis; pleuris* 6, *rarius* 7, *subplanis.*

SYNONYMS. *Cybele sexcostata*, SALTER (June 1848), Memoirs Geol. Surv., vol. ii. pt. 1. pl. 8. fig. 10 (not fig. 9). *Zethus sexcostatus*, M'COY (1851), Synops. Pal. Foss. Woodw. Mus., fasc. 1. 156. *Encrinurus sexcostatus*, SALTER (1852), ib. Appendix A. vol. iv. pl. 1 *g*, fig. 6, 7.

We are induced to figure this trilobite, although it is not quite perfect in all its parts, because it completes the illustration of the same species formerly given in the second volume of the Memoirs, where the tail only was figured; and it is the more desirable to present it in illustration of the genus, as the two species which are best known, the *E. punctatus*, and *variolaris*, are chiefly Upper Silurian, and have been fully illustrated lately in the "Geological Journal."

In the general, appearance, in the structure of the remarkable elevated eyes and of the hypostome, the coarse tuberculation of the head,—the many-jointed axis of the tail, and its few lateral ribs, there is the greatest similarity to *Cybele*,* with which genus

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* *Zethus* of Pander and Volborth, a name which we cannot adopt, because Pander's ill-defined genus was chiefly founded on a *Cheirurus.*

we have hitherto considered it identical, although there are 12 body rings to the latter, and only 11 in *Encrinurus*. But the delineations of the facial suture given by Drs. Volborth and Kutörga in the Transactions of the Royal Mineralogical Society of St. Petersburgh, 1848, show that in this important particular, as well as in the number of body rings, the two genera differ; and when to this is added that the hinder segments of the thorax are not in *Encrinurus* produced into long spines but are all equal, we have a combination of characters sufficient to justify the separation. But there are species of *Cybele* whose habit is so like that of *Encrinurus*, that should a species hereafter be found with the facial suture of one of these groups, and the number of body rings distinctive of the other, we should recommend their reunion as sections of one natural genus.

Description.—Length about an inch and a half, breadth an inch. Some specimens must have been larger. General form broad-ovate; the head and tail convex, the body rather flat. Head about equal in length to the tail, but shorter than the thorax; its shape triangular, the lateral angles produced, the front rounded, gibbous, and overhanging. The glabella occupies full one third of the width of the head in front, where it is much inflated and more than hemispherical; it overhangs the margin, which, as is usual in the genus, is not distinctly separated from it in front, but within the margin and above it on the glabella, there is a strong furrow which runs quite across the glabella, separating from it a thick prominent ridge (fig. 3, *a*) so completely that it appears not to form a part of the glabella, but to belong to the thickened front margin.* The entire glabella is pyriform, constricted behind to half its width, and separated by a strong sulcus from the neck segment, which is broad and prominent. It is indented half-way up by three short furrows on each side. The cheeks, though convex, are much less so than the glabella, and they bear the eye in the middle of the cheek. In our specimen the eyes are broken off, but in all probability they were elongated, and directed forwards and outwards, as we have indicated by the dotted lines in our fig. 2. The outer margin of the cheek is thick, and separated by a furrow, and the posterior angles are produced into spines; the posterier edge also has the strong neck furrow continued along it. The glabella is covered with tubercles of unequal size, mixed with granules, but the specimen does not show whether these tubercles have each a pit on their summit; it is probable they are so constructed, like those of the other species in the genus. The raised fascia, too, in front, has so worn a surface that tubercles are not visible, if they ever existed. The cheeks, instead of being tuberculate, are pitted like those of *Cheirurus* or *Amphion*, and the raised interstices are covered with fine granules. The margins appear smooth, or only finely granular. We have no specimens of the hypostome, or indeed any part of the under surface of the animal.

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* This singular furrow is probably the place of the facial suture, which in this genus crosses the front of the glabella. This suture is not visible in our specimens; but its course in front is well seen in *E. variolaris*, figs. 13 and 14, *a a*.

The thorax consists of 11 segments; the axis moderately convex, of nearly equal breadth throughout, and considerably narrower than the pleuræ. These are quite horizontal as far as the fulcrum, which is placed more than half-way from the axis; and from this point they curve backward and downward to the tip, which is again a little bent forward, so that the line from the fulcrum outwards is a sigmoid curve; the hinder pleuræ curve less backward. Each pleura is nearly semicylindrical, with three or four tubercles along it, and there is little or no space anteriorly for the narrow flat rim which exists in the species of *Cybele*, and which we have called sometimes the fulcral portion.* We have not the extreme ends preserved; but from what has been observed in *E. punctatus* and *E. variolaris*, there is little doubt it was terminated by a bilobed tip, such as we have indicated by dots in fig. 7; the notch *c* being in front of the blunt outer tip, and indenting the end of the facet *b*. This facetted or flattened portion, which passes beneath the preceding ring in rolling, is shown in fig. 8, *a*.

Tail of a triangular form, wider by one third than the length, with an obtuse rounded apex, and flattened above, the sides and the tip deflected, so that the tail is moderately convex; the axis at the upper part is about one fourth the width of the tail, and tapers to a point at some little distance within the blunt apex; it is convex at its broadest end, and there the rings are continuous across, but from about the upper third it becomes flatter, and the rings are effaced along the middle; its apex is quite flat. There are about 20 rings in all, and no tubercles down the smooth central portion. The sides of the tail have six strong ribs, which are broad and somewhat flattened, divided from each other by narrow deep furrows, and have the tips squarish and obtuse. The ends of the four upper ones are free (or rather much overhanging the margin); the remaining two are distinct nearly as far as to the margin, but they there become fused with those from the opposite side, and extend in a very blunt point beyond the tip of the axis. The uppermost ribs arch strongly outwards, the next less so, and the last pair lie parallel to the axis.

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* In this genus, as in *Amphion*, *Acidaspis*, and some others, the pleura is not divided by a groove along its middle as it is in *Calymene*; the division into two parts, an anterior or fulcral portion and a posterior portion, exists, but the latter occupies nearly all the outer surface of the pleura.

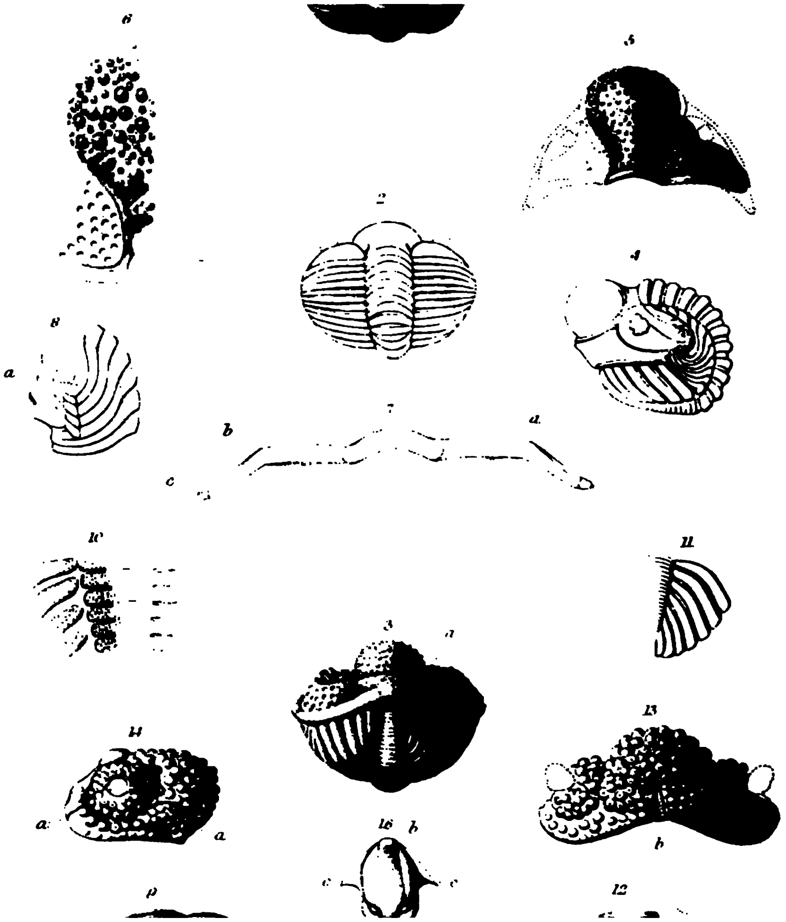
On the internal cast, the furrows, especially those which bound the axal lobe, are all stronger and deeper, but there is no other difference. Externally the whole surface of the tail is covered with a close scabrosity (see fig. 10).

Variations.—In the cast from Sholes Hook (fig. 12) the rings on the axis of the tail are effaced down the middle for a broader space, and there are but few of the upper rings continuous across. Our figure in this case does not show the uppermost rings. There are sometimes (fig. 11) seven rings on each side of the tail.

Affinities.—When perfect specimens are obtained, there is no published species with which ours can be confounded. The subglobular shape of the glabella, with its small tubercles, and the pitted, not tubercular cheeks, will easily distinguish imperfect portions of the head from all other British species. The separated tail, especially internal casts of it, may possibly be confounded with the same portion of *E. punctatus*, but the want of a central row of tubercles down the axis, and the arched lateral ribs, will enable observers to distinguish it. The other Lower Silurian British species, *E. multisegmentatus*, Portlock, is diametrically opposed in all its characters; it has a large coarsely tubercular head, and many-ribbed tail. Nor can the detached tail of our species be confounded with that of *Cybele verrucosa*, Dalman, so abundant in company with it, if the four tuberculate lateral ribs of that species be attended to. Ours has six or seven smooth ones.

History.—We first described this in 1848, in the work above referred to, under the name *Cybele sexcostata.* In those figures there was associated with the tail, but only provisionally, a coarsely tubercular head, which occurred so frequently in company with it, that the two might reasonably be supposed to belong to each other. The figure we now give justifies the caution there expressed, for it is the "more clavate form of head rarely occurring," which properly belongs to the species; the head figured in company being, we are now all but certain, that of the *C.* (*Calym.*) *verrucosa*, Dalman, a species which we hope hereafter to illustrate as the British type of the genus *Cybele*, Lovén.

It had been previously described in manuscript for Professor Sedg-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wick's intended memoir on the fossils of Westmoreland and Wales; and a short description of it will be found in the Appendix to the second fasciculus of his large work on the "British Palæozoic rocks;" it is also described by Professor M'Coy, in the first fasciculus, as *Zethus sexcostatus*.

British Localities and Geological Range.—LLANDEILO FLAGS. Rhiwlas and Llwyn-y-ci, north-west of Bala Lake; and Llechwedd Ddu, east of the lake, North Wales; in the former locality very abundant; Sholes Hook and Pelcombe Cross, Haverfordwest. Not yet found in Ireland.

EXPLANATION OF PLATE IV.

Fig. 1. Coiled specimen; from Rhiwlas.
Fig. 2. Do.; back view, to show the 11 thorax segments.
Fig. 3. Do.; showing the raised fascia *a*.
Fig. 4. Do.; side view.
Fig. 5. Imperfect head; the dotted lines are added from other specimens; the cheeks show the pitted surface.
Fig. 6. Magnified portion of head.
Fig. 7. A thorax segment enlarged; at *a*, the fulcral point; *b*, the facetted surface, and *c*, the blunt indented tip, as usual in the genus; they are added in dotted lines as the specimens are not perfect enough to show them.
Fig. 8. Side view of the pleuræ in the coiled state; at *a*, one of the facetted surfaces is seen by the breaking away of the other segments.
Fig. 9. Tail of a Rhiwlas specimen.
Fig. 10. Part of the same, magnified, to show the scabrous surface.
Fig. 11. Variety of tail with 7 side ribs. Rhiwlas.
Fig. 12. Internal cast of variety with the central part of the axis more free from ribs. Sholes Hook.
Fig. 13. Front view of the head, slightly enlarged, of *E. variolaris*, to show the course of the facial suture in front of the head, and the vertical suture *b*, which divides the cheeks, filled at its lower end by a narrow triangular rostral shield. Wenlock limestone of Dormington, Woolhope.
Fig. 14. The same, a side view; *a a*, facial suture.
Fig. 15. Under view, somewhat enlarged, of the tail of *E. punctatus*,* to show the incurved scabrous margin which unites the lateral ribs of the tail; their free points are seen projecting beyond it. Walsall, near Dudley.
Fig. 16. Hypostome of do., enlarged; *a*, sinuated margin; *b*, cucullate base; *c*, the points of the extended base of attachment. Walsall.

The above figures are all from specimens in the collections of the Geol. Survey. The last four figures are enlarged to once and a half their natural size.

Notes on the other British species of the Genus.

If the strict rule of priority were observed, irrespective of clear definition, we should be compelled to adopt the name *Cryptonymus* for this genus, as that of *Zethus* for *Cybele*. Dr. Kutörga, indeed, in the journal above quoted (1848), advocates this course, and has restored the name *Cryptonymus*, under which Eichwald at first described several varieties of the common *Asaphi* of the Russian Silurian Rocks. Subsequently, aware of his error, he restricted *Cryptonymus* to such trilobites as the *Calym. variolaris*, Brong., including the *C. punctatus*, and some forms of Cybele. But, though thus marking out the group he intended, he gave no description of the amended genus; besides which he was now applying the name to a totally different set of fossils to those for which it was originally intended. Under such circumstances it is impossible to retain his name in opposition to the genus clearly indicated, though not sufficiently described, in Emmerich's scientific arrangement, 1845. The latter name has been adopted, and the typical species fully characterized by Professor M'Coy (Synopsis Sil. Foss. Irel., 1846). The genus *Encrinurus* has a nearly universal range, being found in Silurian rocks from Russia to North America, and from the Arctic regions to Australia; and it has rather an extensive geological distribution, being found in Lower and Upper Silurian, and in the Devonian strata of Germany. *Cromus*, Barrande, a Bohemian fossil, is probably of the same genus; it has, however, four lateral lobes to the glabella, instead of three.

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* See description at the end.

2. E. PUNCTATUS. Brünn. sp. Pl. 4. f. 14–16.

Syn. *Entomolithus paradoxus*, Linnæus, 1759, Act. Reg. Acad. Sc., Holm., p. 22. t. 1. f. 2. *Tril. punct.*, Brünn., Kjobenh, Sellsk. Skrivt. nye Samml. 1. 394. *Entomostrac. punct.*, Wahl. (1821), Act. Soc. Sc. Ups. v. viii. 32. t. 2. f. 1.—tail only. *Calym. variolaris*, Brongn., Crust. Foss., t. 1. f. 3 A. (not B.) *Cal. punctata*, Dalm. Pal. 47. t. 2. f. *a*, *b*. Murch. Sil. Syst. (1839), pl. 23. f. 8. *Phacops variolaris*, Emmrich. Diss. (1839), 20. *Asaph. tuberculatus*, Buckl. Bridgw. Tr., pl. 46. f. 6. *Encrinurus punct.*, Emmr. (1845), Neues Jahrb. 42. *Encrinurus Stokesii*, M'Coy (1846), Syn. Sil. Foss. Irel., t. 4. f. 15. Pal. Foss. Woodw. Mus. (1851), p. 158. *E. punctatus*, Corda (1847), Prodr. Tril. Böhm, 91. fig. 55. bona. *Cybele punct.*, Fletcher, Quart. Geol. Jour. (1850), vol. vi. pl. 32. f. 1–5.

E. ovatus, biuncialis; glabellâ clavatâ convexâ sed parum inflatâ tuberculosâ; tuberculis anticis paullo majoribus, in arcu dispositis, sulcis glabellaribus brevibus vix inter tuberculos magnos visis; genis convexis profunde marginatis, tuberculis sub oculo valde elevato angusto collocatis, angulis spinosis; hypostomate basi subcompresso, rostro apiculato; thorace axi pleuris curvatis paullo angustiore, segmento septimo decimoque brevi-spinosis; caudâ longe triangulatâ, lateribus ante apicem nunc planum recurvum, nunc deflexum obtusiorem contractis; costis lateralibus 8 *obliquis, ad apices prominulis; axi nec convexo, annulis crebris per medium omnino obliteratis, tuberculis quinque vel sex in serie longitudinali dispositis.*

Var. α. Calcareus.—Caudâ in mucronem planum seu recurvum producto.

Var. β. Arenaceus.—Caudâ apice deflexo obtusiori.

The original Swedish species appears certainly to differ in no respect, so far as the tail is concerned, from that common in the Dudley limestone; the tubercles on the lateral ribs, on which so much stress has been laid, being always present, either at the origin of the rib or on its surface. And the species is pretty well represented by M. Corda from Swedish specimens. The thorax rings we have not seen from Sweden, but they are tuberculate as ours are, according to the figure above quoted.

The variety we have called *arenaceus* appears to differ only in the abrupt ending of the tail, which, instead of being horizontal and drawn out into a mucro of variable length, as in the limestone specimens from Dudley and elsewhere, is deflexed and blunt. But the specimens from the Caradoc and Llandeilo sandstones agree so well in all other particulars, the tubercles collected round the eye, the number of ribs and tubercles on the tail, &c. &c., that it cannot be separated as more than a variety. Its name indicates its usual habitats, and the deficient development of the tail may be connected with the deficient supply of calcareous matter. Upper Caradoc specimens are almost always smaller; occasionally, as at Bogmine, in Shropshire, they are of full size. Some Ludlow specimens have the glabella narrower, and but four tubercles down the axis of the tail.

Localities.—In Bala Rocks, Pwllheli, Carnarvonshire; Mathyrafal Wood, Montgomeryshire; also Westmoreland and South Wales. In Upper Caradoc Sandstone, var. *β*, May Hill and Tortworth, Gloucestershire, in great abundance, first observed at the latter place by T. Weaver, Esq.; Bogmine, Shelve; in the "Pentamerus Limestone" of the Hollies, and of Buildwas, Shropshire, abundant. In Wenlock Shale; Var. *α*. Woolhope. In Wenlock Limestone; Dudley, Walsall. In Upper Ludlow Rocks; Pilliards Barn, Woolhope. Ludlow Rocks of Marloes Bay, Pembrokeshire, var. *β*.

Foreign Localities.—Sweden, Norway, Russia, in Lower Silurian; Gottland, in Upper Silurian.

3. *E. variolaris*, Brongn. sp. *Calymene*, BRONGN. (1822), Crust. Foss. t. 1. f. 3 B. (not A.) PARKINSON, Org. Rem., iii. pl. 17. f. 16. MURCHISON, Sil. Syst. (1839), pl. 14. f. 1. mala. (not of EMMR.) SALTER, Mem. Geol. Surv. (June 1848), vol. ii. p. 1. 344. FLETCHER, 1850, Quart. Geol. Journ., vol. vi. pl. 32. f. 6-10. *Zethus*, M'COY (1851), Pal. Foss. Woodw. Mus. p. 157.

E. ovatus, obtusus, sesquiuncialis, capite et thorace E. punctato simillimis, sed glabellâ inflatâ, nec anticè tuberculis in serie transverso dispositis, genis per totum tuberculatis, angulis rotundatis; hypostomate basi convexo; thorace axi inermi, pleuris rugoso-tuberculatis; caudâ convexâ brevi trigono, axi convexo pauci-annulato, annulis subæqualibus 9–12 *interruptis et in tuberculos varie dispositos insectis, lateribus costis* 7, *deflexis, sæpe tuberculatis; apice abrupto deflexo.*

Professor Burmeister in the supplement to his valuable work (ed. 2. p. 115), pointed out the obvious discrepancy between the two figures referred by Brongniart to his *Cal. variolaris*, and in a great measure set the synonyms right. But he was wrong in quoting the figures in the Bridgwater Treatise and Emmrich's description as for this species, which has obtuse and rounded, not spinose angles to the head. The characters of the tail are amply sufficient to separate the two common species; and I may add that those of the head, even if the angles are broken, are also well marked, the glabella of *E. variolaris* being inflated and equally clothed with large tubercles, whence the name "Strawberryheaded Trilobite;" while in *E. punctatus* it is convex, but not inflated, and in front has the tubercles distinctly gathered into a tranverse series or crest, a character more marked in our next species. There should be no more confusion as to the names, since the publication of Mr. Fletcher's figures and description quoted above.

Localities.—Wenlock Limestone and Shale. Dormington Wood, Woolhope; Dudley and Walsall (abundant.)

4. *E. multisegmentatus*, Portl. sp. *Amphion*, Portlock, G. Rep., pl. 3. fig. 6 (too many side ribs.) *Ampyx baccatus*, id. (head), fig. 11. *E. multisegm.*, Emmr. (1845), Neues Jahrb., p. 43.

E. sesquiuncialis, depressus? glabellâ valde clavatâ, ad basin angustâ, tuberculosâ, a genis convexis profundè separatâ; tuberculis magnis anteriùs in cristam transversam arcuatam collocatis; genarum tuberculis (nisi duobus maximis), minoribus, caudâ longè triangulatâ, apice acuto nec producto deflexo, axi angusto annulis numerosis circiter 30, *solùm prope apicem obliteratis; lateribus* 12-*costatis, costis arcuatis deflexis.*

The crest of large tubercles, parted in the middle, along the front of the glabella, as well as the numerous ribs of the tail, are good marks of this elegant species. There can be no doubt the two portions above cited belong to each other.

Localities.—Lower Silurian [head and tail], Tyrone; Montgomeryshire [tail only].

J. W. SALTER.

August, 1853.

BRITISH FOSSILS.

DECADE VII. PLATE V.

CYPHASPIS MEGALOPS.

[Genus CYPHASPIS. BURMEISTER. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Head tubercular, strongly margined; glabella very convex, resembling half an egg, much shorter than the head, without lobes, except a small basal pair which are longitudinal, oval, and deeply divided from the base of the glabella (and an obscure furrow above these on each side); cheeks very gibbous, the smooth eyes rising to a high level, without an ocular ridge; facial suture direct forwards to the margin from the eyes, and behind cutting the posterior margin near the angle, which is long-spinous; a small rostral shield present; thorax of 11 to 17 rings (or more ?), the sixth joint of the axis frequently bearing a spine; pleuræ grooved; tail small, of few rings. Κύφος, a convexity; ἀσπὶς, a shield, in allusion to the inflated carapace.]

[Section *Cyphaspis*; glabella moderately large, thorax of 11 rings.]

DIAGNOSIS. *C. parvulus; capite undique granuloso, fronte rotundato; glabellâ subhemisphericâ, nec gibbâ, oculos maximos vix supereminente; lobis posticis obovatis angustis; genis latitudine glabellam æquantibus; angulis longi-cornutis; limbo ante glabellam declivi angusto—vix margini incrassato latiori; thorace segmento sexto armato, spinâ crassâ appressâ caudæ apicem attingente; pleuris inermibus; caudâ lateribus unisulcatis.*

SYNONYMS. *Harpes? megalops*, M'COY (1846), Synopsis Sil. Foss. Irel. pl. 4. fig. 5. *Harpidella megal.*, Ann. and Mag. Nat. Hist. (1849), vol. iv. 412.

We have figured, for the first time in Britain, a complete specimen, of this genus; it has been known for some years on the continent, and is one of those genera which are common to the Lower Silurian, Upper Silurian, and Devonian rocks, while it does not ascend into the carboniferous rocks.

Description.—One of the smallest known species of the genus; its length is never more than half an inch: the head, which is the widest part, is rather more than five sixteenths broad. The usual length is not above three eighths of an inch. General form convex and truly ovate, with the extremities obtuse. Head very convex and strongly granulose, in form about a semicircle, but contracted at the posterior angles just in front of the strong curved spine, so that the sides are somewhat square. The spine is about equal in length to the head; it is directed first obliquely outwards and then curved a little towards the thorax again, reaching as far as to the 7th segment. The glabella is very convex, parallel sided or slightly parabolic if its whole contour be taken into account, but half egg-shaped if the small lateral lobes are excluded; it occupies about one third the width of the head, and extends forwards only about two thirds its length, a considerable though not very broad space being left between it and the thickened front margin. This space, together with the margin itself, about equals one third of the length of the glabella. Only one pair of lobes are present, which lie at the base of the glabella; they are convex, longitudinally ovate, narrow, each about one fifth the entire width of the glabella, and circumscribed by a deep sulcus, which divides them as much from the glabella as from the cheeks. These last are high-conical, and at about half-way up the head and near the glabella, bear the large, prominent, smooth eyes, which rise nearly to a level with the highest part of the glabella; a thick margin, continuous with the front margin, surrounds the cheek, and is separated from it by a strong sulcus, which does not quite reach the termination of the neck furrow; there is no abrupt hollow or any depression at the angle. The facial suture, contrary to its usual course in this genus, turns considerably outwards above the eye to cut the front margin—along which it runs; beneath the eye its course is abruptly outwards to the end of the posterior margin—a little within the base of the spine. The neck segment is tolerably broad and prominent, and the neck furrow deep and straight.

The thorax is much less convex than the head, and is always a little longer than it; it consists of 11 joints, with the axis moderately convex, tapering quickly backward, and of rather greater width than the pleuræ, especially at its anterior and posterior extremities; in front about equal to the width of the glabella. The 6th segment of the axis is greatly swelled and produced backwards, giving rise to a straight horizontal spine, which lies upon the surface of the posterior rings, and nearly reaches the end of the tail. Pleuræ short, flattish, divided nearly to the tip by a strong, straight groove, the fulcral portion being of the same width as the posterior half. The ends are thickened, truncate, and very faintly bilobed; the fulcrum is placed at about half-way along the pleuræ in the middle segments,—at a less distance posteriorly, and beyond it the forward edge of the pleura is sharpened or facetted for the purpose of rolling up. Tail small, transverse, and but slightly convex, much less than half a circle, its entire width being but little more than that of the glabella; the axis is short conical, occupying one third its width, with one distinct ring, another more obscure, and a terminal joint; sides with one distinct upper furrow, which does not reach the margin.

All the prominent parts of the surface of the body are rough with small tubercles; but these are by far most evident on the glabella, cheeks, and neck segment; they are wider apart than their own diameter, and pretty regular in size.

Variations.—The forehead portion of the glabella in our figs. 3 and 3* is much smaller and less inflated than usual, giving the glabella a parabolic instead of sub-rectangular form; and the same variation is less conspicuous in fig. 7. In other respects they seem to be identical. Some Lower Silurian specimens have the space in front of the glabella a little wider than in those from Dudley, but even in Dudley specimens the anterior margin is sometimes narrower than this space and sometimes broader.

Sex.—Under the genus *Remopleurides*, described further on, at plate 8, the possible indication of sex by certain ornaments or appendages to the dorsal surface is adverted to. Of the small number of this species hitherto examined, we have met with no individuals destitute of the spine at the 6th segment, and it is therefore quite possible that it may be characteristic of the species, and not of one of its sexes. In the collection of Mr. Fletcher, of Dudley, one specimen (fig. 7) has the spine nearly double the ordinary length, or twice the length of the five anterior thorax rings. And this variation, which we can hardly help regarding as indicative of the male, is accompanied by a less inflated glabella, the basal lobes being set more widely apart, as above mentioned, and by a somewhat more pointed form of the head. In *C. Burmeisteri*, the large Bohemian species, the curved dorsal spine always occurs on the same 6th segment, and is always long.* But it is at least worthy of remark that the possession of such a dorsal spine is characteristic of the male of some of the *Cymothoadæ*, a group of Isopod crustacea very analagous, though probably not closely allied to, the Trilobites. In the genus *Sphæroma*, the male of one species, *S. diadema*, is characterized by the presence of a spine very much like that of *Cyphaspis*, and occurring too on the 6th thoracic segment; in the female of that species, a rudimentary spine or tubercle is all that occurs. Several others are described, *S. armata*, &c., distinguished by such an appendage; it may perhaps be proved that some of these are males of the unarmed species.

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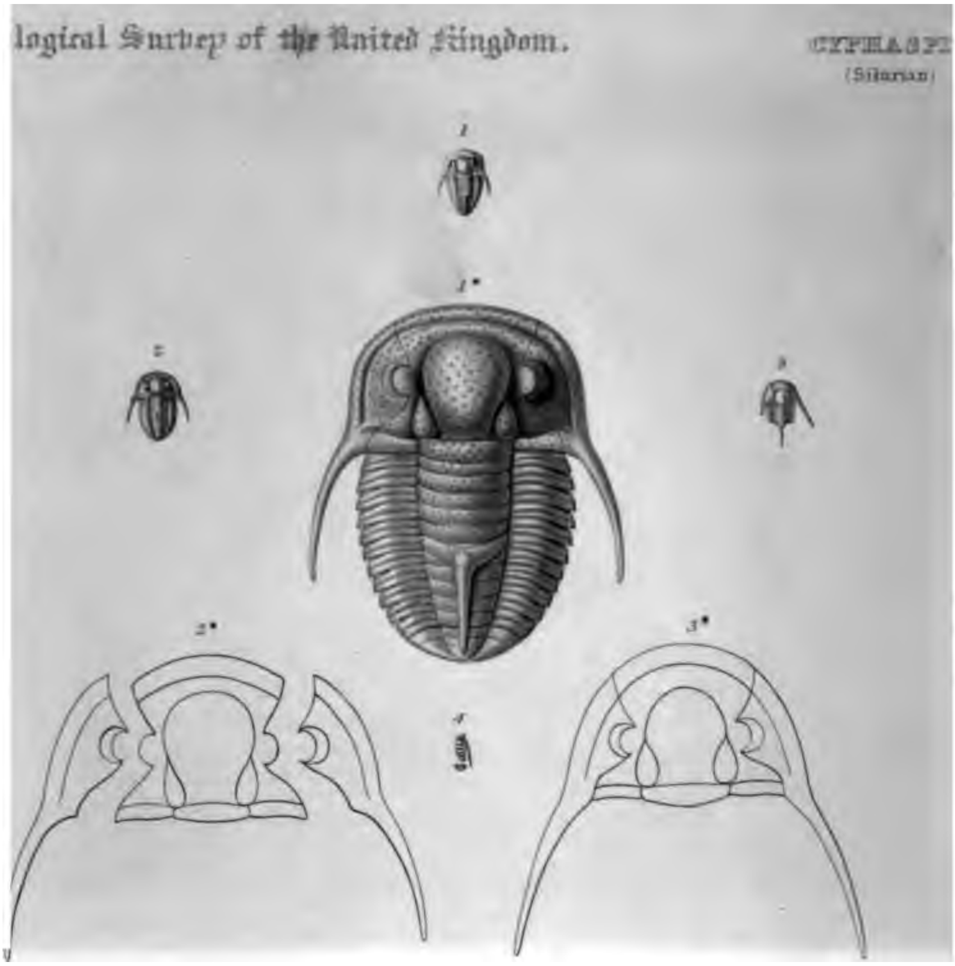
* In *Encrinurus punctatus*, described above, pl. 4, such spines, but much shorter, occur on the 7th and 10th segment; and there are certain trilobites, *Sao hirsuta* and *Bronteus spinifer*, Barrande, for example, that have a prominent spine on every thorax ring: so that we must estimate this character at no more than its proper value.

Affinities.—As nearly all the known species are double the size of this, a close comparison is not necessary; and *Cyphaspis Burmeisteri*, Barr., besides its very much larger size, has 7 to 15 thorax rings according to its age, and the tail with five rings to the axis; the space, too, between the glabella and front margin is very wide: the posterior head spines short, reaching only to the 4th ring. Like our species, it bears a spine on the 6th thoracic segment. *C. Barrandei*, Corda (the species called formerly, with doubt, *C. clavifrons*, by Barrande) has 11 rings, but the glabella is vastly more inflated and the head margin narrow; the posterior head spines, too, are one and a half times the length of the body. *C. cerberus*, of the same author, has the head fringed with spines; and the Devonian species, *C. ceratophthalma*, Goldf., besides its greater bulk and much more convex head, has a scrobicula or pit at each of the posterior head angles. The pretty Swedish species, *C. elegantulus* (*Proetus eleg.*, Angelin), is more like ours, but has an elongate head and 12 unarmed thorax rings. In fact there is no published fossil which can be confounded with it.

The genus is more rich in species than might be supposed, but they have only been discovered of late years. *C. ceratophthalma*, Goldf., of the Eifel, furnished Professor Burmeister with the type, which he described in 1842, in his original work; since which time Barrande, Lovén, and Sandberger have made us acquainted each with a few species. M. Corda has largely swelled the list, dividing the genus into *Goniopleura*, with 12 rings, *Cyphaspis*, with 11, and *Conoparia*, with 13; but the differences he notices are by no means sufficient for the establishment of distinct genera, though possibly the species with a very wide space in front of the glabella, and with more than 11 body rings, may form a sub-genus. Now that we possess the work of M. Barrande, who has discovered the several species with great variations in the number of thorax rings according to their age, (in *C. Burmeisteri*, from 7 to 15), the limits of these sub-genera may perhaps be arrived at. Our species, at all events, will fall into the same group of 11-ringed species, with that originally described by Burmeister.

History.—Abundant but very imperfect specimens of the head of this little trilobite were detected by Professor M'Coy, and carefully described by him in his account of the Irish Silurian


logical Survey of the United Kingdom.
CYPHASPI
(Silurian)
1
1*
2
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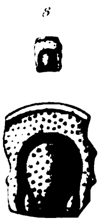

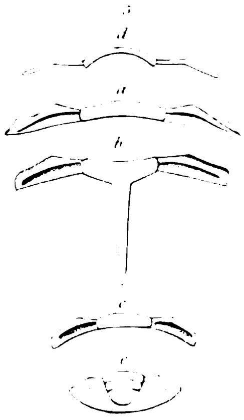

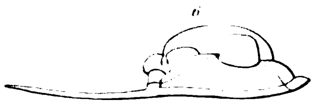

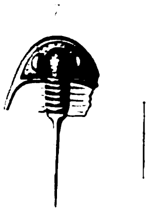

CYPHASPIS MEGALOPS M'Coy

fossils. His specimens were not perfect enough to enable him to see the true position of the large eyes on the head, nor the strong granulation of the glabella, and he referred it therefore, with a doubt, to the genus *Harpes*, suggesting that it might form a new group allied to that genus; this idea was carried out in his classification of the British Trilobites, in the Annals of Natural History, for December 1849, in which this trilobite stands as the type of a proposed new genus, *Harpidella*, and the granulated surface is mentioned. In a communication from him lately, he is agreed with me in identifying these perfect specimens with those described by himself. It is mentioned by myself, Proceed. Brit. Assoc., 1852, Sect. p. 57.

British Localities and Geological Range.—LLANDEILO FLAGS to LOWER LUDLOW ROCK. In Llandeilo flags; sandstones of Ardaun, Boocaun, Cappacorcogue, and Tonlegee, Cong, county of Galway (Mr. Griffiths' collection); limestone of Portrane, county of Dublin; sandstones of Mullock quarry, near Girvan, Ayrshire (M'Coy); Bala limestone of Cader Dinmael, near Corwen, North Wales; in the Wenlock limestone and shales of Dudley and its neighbourhood (figs. 2–6); in the Wenlock shale, west of the Worcester Beacon, Malvern Hills; Lower Ludlow rock, of Hole Farm, near Philsley Beauchamp, Abberley Hills (fig. 1). [Survey Collection].

EXPLANATION OF THE PLATE.

Fig. 1. A nearly perfect specimen, from the Lower Ludlow Rock, Abberley; natural size.

Fig. 1*. The same, enlarged. The tail in this figure is rather too large, both as to length and breadth.

Fig. 2. A fine specimen from Dudley, in the collection of T. W. Fletcher, Esq.

Fig. 2*. The head, magnified, and dissected at the suture. The glabella and its basal lobes are in this of the usual form.

Fig. 3. A variety from Dudley (Mr. Gray's coll.), in which the glabella is shorter and more parabolic in outline; it is a rare variation.

Fig. 3*. The same, magnified.

Fig. 4. A fragment from Dudley, placed laterally in the rock, and showing the dorsal spine parallel to the body, and reaching to the tail. (Mr. Gray's cabinet.)

Fig. 5. Magnified dissections of the thorax; *a*, the anterior segment, with its pleuræ obliquely truncate at their ends; *b*, the 6th segment, showing the broad deep pleural groove and the long dorsal spine; *c*, the last or 11th segment; *e*, the small transverse tail.

Fig. 6. A lateral view of the head, magnified.

Fig. 7. A specimen, from Dudley, with the dorsal spine greatly elongated. Natural size, and enlarged. (Mr. Fletcher's coll.)

Fig. 8. A head from Cader Dinmael, Denbighshire; Bala limestone. Natural size, and enlarged.

Other British Species.

Only one other certain species of the genus has yet occurred in England, and that so like the *C.* (*Proetus*) *elegantulus* from Gottland, that if it were not for some differences in proportion, long head spines, &c., it would have been thought the young of that species. Its characters may be thus given :—

C. pygmæus, sp. nov. [*Proetus elegantulus*, Angelin (1852), Palæontol. Suec., t. 17. fig. 7. Lovén (1845), Ofvers. Kongl. Vetensk. Akad., t. 1. fig. 4. *junior ?*]

C. minutus, ovatus; capite granuloso fronte paullum producto; glabella depressâ genis angustiori, lobis basalibus rotundatis; oculis parvis; limbo antico angusto tumido, angulis posticis longispinosis; thorace segmentis 12, *axi angusto, pleuris acuminatis—posticis recurvatis, fulcro anticè ultra dimidium posito; caudâ minutâ, lateribus costatis.*

Not two lines long, (while *C. elegantulus* grows to an inch and a half,) depressed, the head rather more than one third the entire length; glabella round oval, the small basal lobes full twice their diameter from each other. A narrow and tumid space lies between the glabella and the somewhat produced and narrow front border. The cheeks are considerably wider than the glabella, and bear the small eyes at a short distance from the latter; their angles are produced into long divergent spines, which reach as far as to the 7th or 8th thorax segment. The pleuræ are wider than the axis, and have in front the fulcrum very remote, behind it is not quite one third away from the axis. The tail is very small, the axis and sides are ribbed, but it is too imperfect to be described properly.

The characters above mentioned may be those of a young specimen; but it has the full number of rings, and in this genus they increase in number with age; the head is not nearly so produced in front, nor the glabella so convex as in *C. elegantulus*, and the head spines are proportionally much longer; above all, the Gottland species has blunt pleuræ, and in ours they are decidedly acuminate, the hinder ones being even recurved at the tips; the pleuræ are grooved nearly to the ends.

Locality.—Eastnor Castle, Malvern Hills; in Wenlock shale.

J. W. SALTER.

August, 1853.

BRITISH FOSSILS.

DECADE VII. PLATE VI. Fig. 1, 2, 3.

ACIDASPIS JAMESII.

[Genus ACIDASPIS. MURCHISON. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Capable of rolling up, or even contractile into a ball. Head short, broad, truncate in front; the glabella broadest at the base, with a median portion strongly separated from the three lateral lobes, which are obscurely divided from the cheeks (and often connate with them); cheeks thickened, generally spinose at the margin, and with the angle produced into a spine; eyes smooth, convex, (occasionally elevated on a long peduncle) connected with the front of the glabella by a strong ocular ridge; neck segment much enlarged, and generally produced into spines; body of 9 or 10 segments (fewer during the metamorphosis), with a narrow convex axis, and horizontal pleuræ which are produced at their ends into spines; tail small, axis abbreviated, limb multidentate, with one strong lateral rib on each side produced beyond the margin. ακις, mucro; ασπις, scutum.]

DIAGNOSIS. *A. latus, depressus, granulosus; capite haud convexo, glabellâ triangulari, utrinque lobis duobus ovatis à genâ dilatata fere distinctis—tertio obscuro; oculis medianis; jugo oculari obscuro; angulis brevispinosis; thorace segmentis* 9 *unispinosis, caudâ spinis* 12, *primariis fortibus parallelis, reliquis minutis,—terminalibus sex, externis utrinque duobus.*

SYNONYMS. *Acidaspis bispinosus* (M'COY), SALTER (June 1848), Memoirs Geol. Surv., vol. ii. pt. 1. pl. 9. fig. 5 (not f. 4.) *Acid. Jamesii*, id. (1852), Proceed. Brit. Assoc., p. 57.

We have now sufficient materials to illustrate completely an *Acidaspis* from the Lower Silurian rocks; they are very rare in these formations in Britain, nor are they characteristic of them in other countries, although they are plentiful in the Upper divisions.

The honour of first distinguishing this most remarkable genus is divided between Dr. Emmrich and Sir Roderick I. Murchison; the former having fully characterized the genus* but a very short time after the publication of the "Silurian System," in which the complete head of the more common Wenlock species was figured, and a new genus proposed to mark its peculiarities.

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* De Trilob. Dissert. inauguralis (1839), 53, Berlin.

Of all the extravagant forms of this curious family of trilobites, none seems so extravagant in its ornament as the genus *Acidaspis;* the head, thorax, and tail being literally crowded with spines wherever an available angle occurs. The neck segment is produced into 1, 2, 3, or even 8 spines. In the thorax, the segments of the axis have sometimes two long spines on each, and the pleuræ have spines on their surface, and frequently two, or even three at the extremity; the tail is found with from six to 25 of these projections, and the margin of the head is generally furnished with a spiny fringe; to this last character there are but few parallels in the whole family (it occurs in *Staurocephalus, Calymene,* and *Cyphaspis*); and it may be compared with the perforated fringe of *Trinucleus,* or contrasted with the long frontal spine of *Ampyx.* Yet, in some respects, *Acidaspis* resembles *Lichas* (a genus not yet illustrated in these Decades) in the deep separation of the side lobes from the rest of the glabella, and their frequent fusion with the lateral parts of the head; here, too, as in *Lichas,* the facial suture cuts the posterior margin of the head. The tail also is composed of but few segments, as indicated by the joints of the axis, for the number of spines on the lateral parts probably do not indicate half the same number of real segments.

Dr. Emmrich, who wished to show that all trilobites had nearly the same number of body rings—about 20 or 21—noticed that his genus *Odontopleura* possessed a much fewer number than trilobites in general; and he proposed to consider the thorax segment as compounded of two, the free joints of which were exhibited at the ends of the pleuræ. This, however, is not now tenable, for we have seen some species, which on this view would consist of 40 segments, taking the body and tail both into account. It is quite certain that the anterior and posterior divisions of the pleura are both extended, and this character is peculiar to *Acidaspis,* and to some only of the species. Barrande has shown that the segments of the thorax increase in number with age. The genus is found both in Lower and Upper Silurian, and in Devonian strata.

Description.—General form broad and depressed, the surface granulose, the edge fringed with radiating spines. The length, exclusive of the spines, is eight lines, and the breadth six lines. The head is widely transverse, three times as broad as long, and with the front and back edges parallel; the cheeks obtuse, squarish at the upper angles, or even overhanging, and fringed with about 16 spines, which increase in size towards the outer margin; below these there is an abrupt contraction, followed by a widely divergent spine, which is much shorter than the width of the cheek. The eye is placed midway up the head, a little in advance of the greatest convexity of the cheek, and at one third outwards from the glabella, with which it is connected by a very slightly prominent ocular ridge (perhaps stronger when the crust is perfect). The facial suture appears to run along with this ridge forward, and behind the eye it takes an outward direction and cuts the posterior margin just under the base of the angle spine. The neck furrow is very strong, and is overhung by the gibbous inner base of the cheek.

Glabella broadly triangular, not very convex, with a distinct median lobe and two pairs of round lateral lobes, besides a third upper pair, which are small and not distinctly separated from the cheeks. The basal lateral lobes of the cheeks are equal to the median lobe in width, and are well separated from the most convex portion of the cheeks; above they are fused with them, as is also the upper or second lobe on its outer edge, but both of these lobes are circumscribed above and below, and on their inner edges by deep furrows; the glabella appears on the whole to be quite distinct from the cheek. The néck segment is not cut off by any distinct furrow; it is convex, expanded backwards, and produced into two somewhat divergent spines, about equal in length to the glabella. The front of the head is truncate, and its middle portion as usual free from spines. Surface of the head covered with large and small granules, set thickest on the glabella and gibbous base of the cheeks.

Thorax horizontal, except the very convex axis which occupies rather more than a quarter its width; of 9 segments, which are each semi-cylindrical (*plèvre à bourrelet,* Barrande), and ornamented with granules (fig. 2). They terminate in a strong spine equal in length to the pleura, and bent backwards at right angles to it on the hinder segments; in the forward ones the spines are shorter, and set at an obtuse angle. When the interior cast of the thorax is examined (fig. 3), the pleuræ are not seen as semi-cylindrical, but much flatter, and a broad raised ridge runs obliquely along their upper border, leaving a flat space behind. This is, of course, due to the different thickness of the crust at different points.

Tail minute, semicircular, with a small, narrow, and convex axis of two joints, the limb flat, except the convex ridge which runs obliquely from the axis to the primary spine on each side. These spines are directed backwards, parallel to each other, and extend nearly as far as those which run out from the last of the body segments. Between these are six small equal marginal spines, and a pair of similar spines outside the large ones on each side of the tail.

Scattered granules, like those on the head, are sparingly distributed over the more convex parts of the body rings, and occur both on the axis and sides of the tail (fig. 2*). The spines are all smooth.

Variations.—We have only three specimens, and between our figs. 1 and 2, and fig. 3, the only differences seem to arise from the greater pressure to which the latter has been subjected. In fig. 3, preserved in soft black slate, the axis is widened and depressed, the pleuræ less convex, and their spines more divergent, and the glabella is somewhat widened and deeply furrowed. In addition, the cheek margin appears to overhang more, and to be contracted much more decidedly above the spine. The terminal spines of the tail, too, are rather more crowded.

Affinities.—Except with the species next described, and with which I formerly united it, there is no British fossil which has any near resemblance. Among foreign species, *A. mira*, Barrande, has a pair of neck spines, but has the eyes far backwards, and is a true *Acidaspis ; A. Prevosti* and *A. Dufrenoyi*, Barrande, which belong, perhaps, to the same section with *A. Jamesii*, have but four terminal and two extremely long primary spines to the tail; and *A. Verneuilii* and *A. vesiculosa*, which belong to the section Trapelocera, and possess each two neck spines, have the eyes remote, as in the Wenlock species quoted in our next description.

Locality and Geological Position.—LLANDEILO FLAGS. Fig. 1, 2, from the sandy schists of Newtown, Waterford. Fig. 3 is in black slate, Duncannon, Wexford. (Mus. Geol. Survey, collected by Capt. James, R.E.)

ACIDASPIS BISPINOSUS.

DECADE VII. PLATE VI. Fig. 4.

DIAGNOSIS. ***A. capite convexissimo, glabellâ lobo mediano ovali gibbo per totum capitis extenso, lobis lateralibus utrinque tribus minutis linearibus; oculis ante medium genarum positis; cervice bispinoso.***

SYNONYMS. *A. bispinosus*, M'COY (1846), Synopsis Sil. Foss. Ireland, pl. 4. fig. 7. (not *Odontopleura bispinosa*, EMMRICH, 1845), see M'COY, l. c.

The head only of this species is known, and it is remarkable for the extreme gibbosity of the central lobe. Our specimens are about four lines wide; the one figured by Professor M'Coy is double that size.

Head scarcely thrice as wide as long, and the convexity equal to three fourths the length. The glabella extends nearly the whole length of the head; it is narrow, oval, and nearly all occupied by the swelled central lobe, the two linear oval lateral lobes on each side, and a minute upper third one, only skirting the base of the large central one, and not indenting its sides, as they do in most other species. In front, this protuberant lobe pushes forward the anterior margin and makes it sinuous, and behind it is immediately succeeded by the two short diverging neck spines (with a small tubercle between them), no space being left for a large neck segment. The cheeks are roundish, rather convex, and steeply bent downwards, as shown in our lowest figure, which is a section of the head; they have a thickish border separated by a strong furrow, and studded on the edge by several small spines, and they are enlarged outwards so as to overhang the base of the stout spine which occupies the posterior angle. Between the projecting anterior margin of the cheeks and the equally projecting front, the border is depressed on each side of the glabella, so as to form a hollow curve in which the facial suture terminates. The posterior margin of the cheeks is uneven, and shows a slightly impressed neck furrow. The eyes are apparently large and prominent, with a tubercular eye lobe, and are placed full half-way up the cheek, and about half-way outward, or rather more, from the convex lobe of the glabella. Between the eye and the small glabella lobes, and parallel to the latter, the space is filled up by a longitudinal swelling or lobe, rising above the surface of the cheek, but fused with it towards its prominent base. An oblique ridge below the eye connects that organ with the stout widely diverging cheek spine, and along this ridge the facial suture runs, and is supposed to terminate just within the base of the spine, but the head could not have been separated at the facial sutures. Coarse tubercles, with a few finer ones, cover the whole of the head except the shallow furrows; they are not, however, distinct on the cheek border, nor on the ocular ridges.

Affinities.—Now that we have a perfect head of this species, there is no other with which it could be confounded. The figure given by Professor M'Coy, cited above, is quite correct, but it was from a very fragmentary specimen, and both he and myself regarded the first found specimens of *A. Jamesii* as identical with it. That species, however, as contrasted with small and more perfect specimens we now possess, differs by its depressed form, and by its lobed glabella, with the median lobe moderate as compared with the side ones. In this species it is monstrously developed at the expense of the others,.which are reduced to mere rudiments. The eyes, too, lie more outwards and forwards, and in this as well as the gibbosity of the head, a nearer approach is made to the typical species of the section *Trapelocera.*

The common two-spined Wenlock species (most inadvertently connected with it in the "Memoirs Geol. Surv.," vol. ii. pt. 1. pl. 9. fig. 4) has much more remote eyes, and the glabella lobes quite fused externally with the cheeks. It probably belongs to the same section with those now described, and if not identical with the *A. (Trapelocera) vesiculosa,* Beyrich, is very closely allied to it. Mr. Fletcher, of Dudley, has named it *A. Barrandii,* and will publish it shortly. It must form the subject of a future plate, as it is the type of the sub-genus *Trapelocera.*

Professor M'Coy, in his work, has shown that this has nothing in common with the *Od. bispinosa,* Emmr., a name proposed by him to be substituted for *O. ovata,* by which he formerly (Dissertatio Inauguralis, 1839,) designated his species; the name in that case refers to the double spinous terminations of the pleuræ, not to the projections from the neck, which appears to be smooth and unarmed.

British Locality and Geological Position.—LLANDEILO FLAGS. In the limestone of the Chair of Kildare, county of Kildare, which, by its numerous fossils, is exactly referable to the age of that of Llandeilo and Bala. [Coll. Geol. Survey.]

EXPLANATION OF PLATE VI.

Fig. 1. Head of *Acidaspis Jamesii,* natural size. Newtown, Waterford.

Fig. 1*. The same magnified.

Fig. 2. Body; shows also portion of the head. Same locality.

Fig. 2*. Portions of the same, magnified; *a,* external surface of one of the thorax rings; and *b,* the 12-spined tail.

Fig. 3. Interior cast of another specimen from the slates of Wexford. This specimen is the same as that figured Mem. Geol. Survey, vol. ii. pt. 1. pl. 9. f. 5.

Fig. 3*. Shows portions of the same, magnified; *a,* the cheek with its spines; *b,* the tail with its marginal spines.

Fig. 4. *Acidaspis bispinosus,* M'Coy, nat. size. Chair of Kildare. [Survey Coll.]

Fig. 4*. The same. magnified.

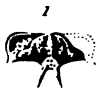
Fig. 5. Section of the gibbous head.

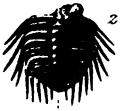
Fig. 6. Tubercles and granules of the surface, highly magnified.

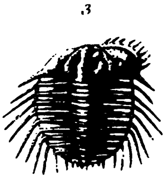
Notice of one or two other British Species.

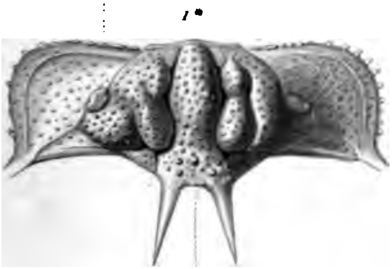
3. There is a species found in the Bala Limestone, of which we have only a portion of the head. It differs from *A. Jamesii* in having fewer and larger tubercles on the head, and the central glabella lobe broader in proportion to the side lobes; it is too imperfect to name.

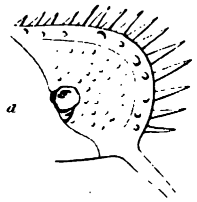
4. The head of a small species, about equal in size to our figured specimens of *A. bispinosus,* occurs with it very rarely in the Chair of Kildare, Ireland. The central glabella

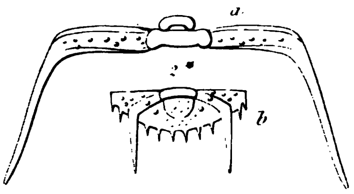


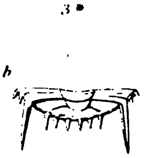


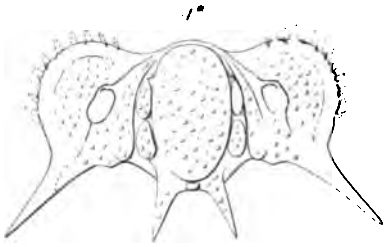


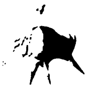


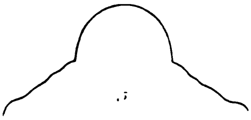


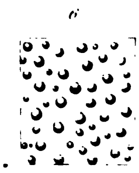












1–3 ACIDASPIS JAMESII *Salter*

4 BISPINOSUS *MCoy*

lobe is very large, and the lateral ones minute and pressed against the sides, as in that species, but the former is parallel-sided instead of oval, not nearly so convex, and instead of being covered equally with small tubercles, is studded with a double row, five on each side and a terminal one, of large boss-like ones, between which the surface is finely granulated. Similar large tubercles occur on the space between the glabella and the forward eyes, and even on the front margin. If it were more complete (we have only the central part of the head without the cheeks), it might be called *A. biserialis*.

5. There is a narrow transverse caudal shield, also from the Chair of Kildare, the hinder margin of which is closely serrated by 19 long spines, the primaries being not much longer than the others. It resembles *A. radiata*, Goldfuss.

Lastly in the Llandeilo or Bala rocks (" Caradoc sandstone ") of Shropshire, a small and pretty species, half an inch long, occurs. It has six terminal spines to the tail, as in *A. Jamesii*, but the primaries are more divergent, as are the spines of the thorax. The head has longer spines at the angles, and the glabella is truly triangular and very distinct from the cheeks, the lowest lobes much larger than the second, and the uppermost quite obscure. The eyes are more backward and the cheeks much smaller. We may define it thus :—

6. *A. Caractaci*, sp. nov. *A. semiuncialis, capite semilunari convexo, glabellâ late triangulatâ, tuberculatâ, a genis convexis bene distinctâ, utrinque bilobatâ ; lobo basali centralem æquante rotundo circumscripto, quam secundo duplo latiore, hoc distinctissimo obovato : superiori obsoleto :* [*cervice*—?] *thorace axi convexo, pleuris ad apices deflexis bispinosis, caudâ* 12 (*vel* 14 ?) *dentatâ, spinis primariis fortibus paullum divaricatis, terminalibus minutis* 6, *externis* 2 (*vel* 3) ; *axi convexo.*

Locality.—Gretton quarry, near Cardington ; a locality rich in all the characteristic Bala species. *Lichas laxatus*, *Phacops conophthalmus*, and *P. truncato-caudatus*, *Calymene Blumenbachii*, *Illænus*, &c. occur with it.

The species which is to be considered the true type in Britain of the section *Acidaspis* proper, is the *A. Brightii*, Murchison, which we hope, with the assistance of our friends at Dudley, to publish hereafter. Several British species will then be enumerated as belonging to that section, and among them a new species, *A. coronatus*, Salter, formerly called *A. Brightii* (Mem. Geol. Surv., l. c. pl. 9. f. 8. 9.)

J. W. SALTER.

August, 1853.

BRITISH FOSSILS.

DECADE VII. PLATE VII.

TRINUCLEUS LLOYDII.

[Genus TRINUCLEUS* (Llhwyd) MURCHISON. (Sub-kingdom Articulata. Class Crustacea. Tribe Trilobitæ.) Head of one piece, the facial sutures being soldered; the margin expanded into a hollow fringe, with several rows of perforations; eyes minute, sometimes absent; hypostome convex, elongated, without furrows. [BARR.]; body six-ringed, fewer, 0–6, during the metamorphosis. CRYPTOLITHUS, Green.]

[Sub-genus *Trinucleus*. Eye line and ocular tubercle obscure; glabella lobes indistinct.]

DIAGNOSIS. *T. rotundus planus, testâ tenui; glabellâ pyriformi abbreviatâ nec genas excedente, subcarinatâ; cervice spinifero; fimbriâ marginali concavâ, punctis minutis radiatis crebris in ordines* 6 *concentricos collocatis; alis magnis triangulatis, caudam attingentibus, spinis longis parallelis [nunc truncatis inermibus?]; caudâ concavâ truncatâ, sulcis lateralibus.*

SYNONYMS. *Trinucleus Lloydii*, MURCHISON (1839), Silurian System, tab. 23. fig. 4. EMMRICH (1839), Dissert., p. 53. MILNE EDW. (1840), Crust., vol. iii. 331. *T. granulatus* (Wahl.), BURMEISTER, Trilob. (1843), 66; 2d ed. (1846), p. 57. SALTER (July 1847), Quart. Geol. Journal, p. 254. PHILLIPS and SALTER (June 1848), Memoirs Geol. Surv., vol. ii. pt. 1, p. 240.

VAR. β. *Corndensis.—angulis posticis capitis brevioribus*, figs. 2 and 6.

This elegant species is abundant in Carmarthenshire and in the mining district of Shropshire, the only localities in which it has yet been observed; for although it has been supposed identical with a species common in Sweden, it is apparently quite distinct, and it is here figured as well to clear up this point, as because it is an excellent illustration of the remarkable genus to which it belongs.

Description.—Length about three quarters of an inch, and width one inch. General form flattish, especially behind,—circular, or, excluding the fringe, a very broad oval, and with long spines directed straight backwards and reaching far beyond the tail.

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[*] From *tres*, three, and *nucleus*, in allusion to the three convex portions of which the head is composed.

Head occupying more than half the entire length, and forming a semicircle, exclusive of the long depending ears which reach to about the middle of the tail. The glabella is pyriform, moderately convex, not equal in width to the cheeks, nor reaching quite to the fringed border in front, but separated from it by a narrow convex space (fig. 7, *b*.) In the strong furrow which surrounds the glabella, and at the anterior part, in a line with its front edge, are placed the two deep indentations characteristic of the genus * (fig. 6, *a*). The glabella is carinate along its lower half; it has on each side a slight longitudinal depression, and at its very narrow base one obscure lateral sulcus above the neck furrow. The neck lobe is produced into a rather strong spine, with a broad base. Neck furrow shallow, continued along the posterior edge of the cheek, which is straight half-way, and then bends suddenly down to form the margin of the large triangular pendant ear; this is slightly concave, pierced by close set puncta, and bordered all round by a raised margin, even at the head angles (fig 4, *a*), where the spines are attached. The fringe which encircles the front is strongly concave on its upper surface, with a thick flattened edge, and very convex below, except just at the margin, where it is plain (see fig. 3); it is closely beset by radiating rows of small holes, six or seven in a row. Of these rows on the upper surface the two outer pores are set close together just within the thickened edge, the next pore much more remote, and placed at rather a greater distance from them than from the three or four close set rows which range along the inner edge (see fig. 1*). The fringe is equal in width all along the front, the glabella not invading it, as it does in some other species. On the under side (fig. 3) the fringe shows a similar arrangement, the space between the second and third row being much more considerable than the others, and frequently rising into a ridge. The spines are not very strong; they project abruptly from the posterior angle, and are not thicker at their origin than elsewhere; their direction is a little inwards rather than directly backward. In some specimens they are as long as the glabella, in others longer than it.† The body, of six flat joints, is equal in length to the tail, and the axis alone shows any convexity; it is narrow, not occupying above one sixth the width of the thorax, and consequently is much narrower than the glabella; its rings show the usual division into two parts, an external arch and an articulating front portion. The pleuræ are truly flat, and only marked with a very faint diagonal furrow, but at their extreme end they are a little bent down and strongly indented (fig. 5). The fulcrum (fig. 5, *a*) occurs immediately before the tip. Tail rounded, truncate, less than a semicircle, concave, except the axis; the latter is moderately convex, narrow, and tapering to a point which reaches the margin; it is annulated by seven or eight faint rings, which are indented in the middle. The sides of the tail have seven or eight furrows, nearly reaching the margin; the upper one is straight or nearly so, the ends of the rest are strongly curved backwards. The very narrow margin of the tail is bent down vertically, so as to be invisible in a direct view; a small portion only of it is seen at *b* in fig. 1*, where the tip of the tail is decidedly recurved.

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* Professor M'Coy considers this an antennary pore, but this is very unlikely; it answers exactly to the place where, from M. de Barrande's discoveries, the ascending processes of the hypostome are attached.

† The facial suture cannot be traced in this species; in others, and especially in the section *Tretaspis*, it runs from the upper corners of the glabella to the eye, and thence to the posterior margin, just within the punctate border. I have formerly described it in this position, and cannot admit the opinion that it runs round the outer margin of the fringe. [See Barrande, Syst. Sil. 615, &c.]

Variations—In many specimens the pendant ears are not so long as in our figured example, and consequently the posterior angles are more obtuse. This is particularly the case with those from the mining district of Shelve and Middleton, in Shropshire; these specimens have also smaller head spines, and the ears are much smaller, and are truncated so as hardly to reach back beyond the first or second thorax ring. This variation may be designated by the name *corndensis*, and if at all common (we have only seen it in specimens from one locality at present) may probably be characteristic of the female. We have figured a young specimen of it at fig. 2, and the head, magnified, fig. 6. The fringe in this specimen is scarcely concave, and the collocation of the pores into rows very indistinct toward the sides.

Affinities.—It is sufficiently distinct as not to be easily confounded with the common species, *T. concentricus*, Eaton, (known better in England as *T. Caractaci*, Murch.) The great size and pendant form of the large head-wings easily distinguish it from that species, and also from the *T. fimbriatus*, Murch. The concave character of the fringe distinguishes it from *T. radiatus*, Murch., which too has a square form of head, from the enlargement of the *upper* corners of the fringe, and divergent not parallel spines. Its nearest ally, to which, indeed, several authors have referred it, is *T. granulatus* of Wahlenberg and Dalman. Good means of comparison, however, are now given us by the accurate figures of Lovén, who of course has access to the very specimens described by the Swedish authors, and from his figure and description, *T. granulatus* differs in the thicker crust, and in the size, different shape, and greater extension forwards of the glabella, which invades the area of the fringe in front, while in our species it scarcely ever reaches to it. The width of the axis, too, in the tail and thorax, is considerably greater, and the tail, though like in shape, is destitute of lateral furrows, and at its margin is steeply bent down ("præcipiti"). The punctation of the head (if indeed Lovén's specimens were perfect in this part) shows but three or four rows at the most, and the outer row much enlarged (probably having two puncta in a common depression) while in ours they are numerous and of nearly equal size.

History.—First described by Sir Roderick Murchison from specimens gathered at Llangadock by the Rev. Henry Lloyd, after whom the species is named; this figure, however, though characteristic, was from a specimen with but five rings, evidently an accidental growth. The peculiarity, however, was noticed by Lovén,* who doubted its identity with his *T. granulatus* from this circumstance. Burmeister had previously, in 1843, united it with the Swedish species, and in accordance with his suggestion and from the great general similarity of the pendant ears and rounded tail, it was named *T. granulatus* by myself in the "Journal of the Geological Society," and in the lists drawn up by Professor Phillips and myself in the Survey Memoirs. I am glad now, from good specimens, and more close observation, to correct the error.

British Localities and Geological Position.—LLANDEILO FLAGS. In Carmarthenshire; Dynevor Park, and Mærdy bach, Llandeilo; Blaen-dyffryn-garn and Coed Sion quarries, Llangadock, abundant; in Shropshire, Middleton and the country about Chirbury and Shelve, also plentiful.

EXPLANATION OF PLATE VII.

Fig. 1. Perfect specimen, from the Coed Sion quarries, Llangadock. Presented to the Museum of Practical Geology by the Rev. H. Lloyd.

Fig. 1*. The same, magnified, showing the concave fringe perfect on the right hand of the specimen, and on the left, at *a*, the hollow impression left by its convex lower surface. The thorax and tail are represented as separate from the head; and at *b*, the abruptly vertical margin of the tail is just visible at the recurved tip.

Fig. 2. A small specimen of the var. β, with the fringe flattened above (from pressure?); the ears in this variety are much smaller than in the ordinary form.

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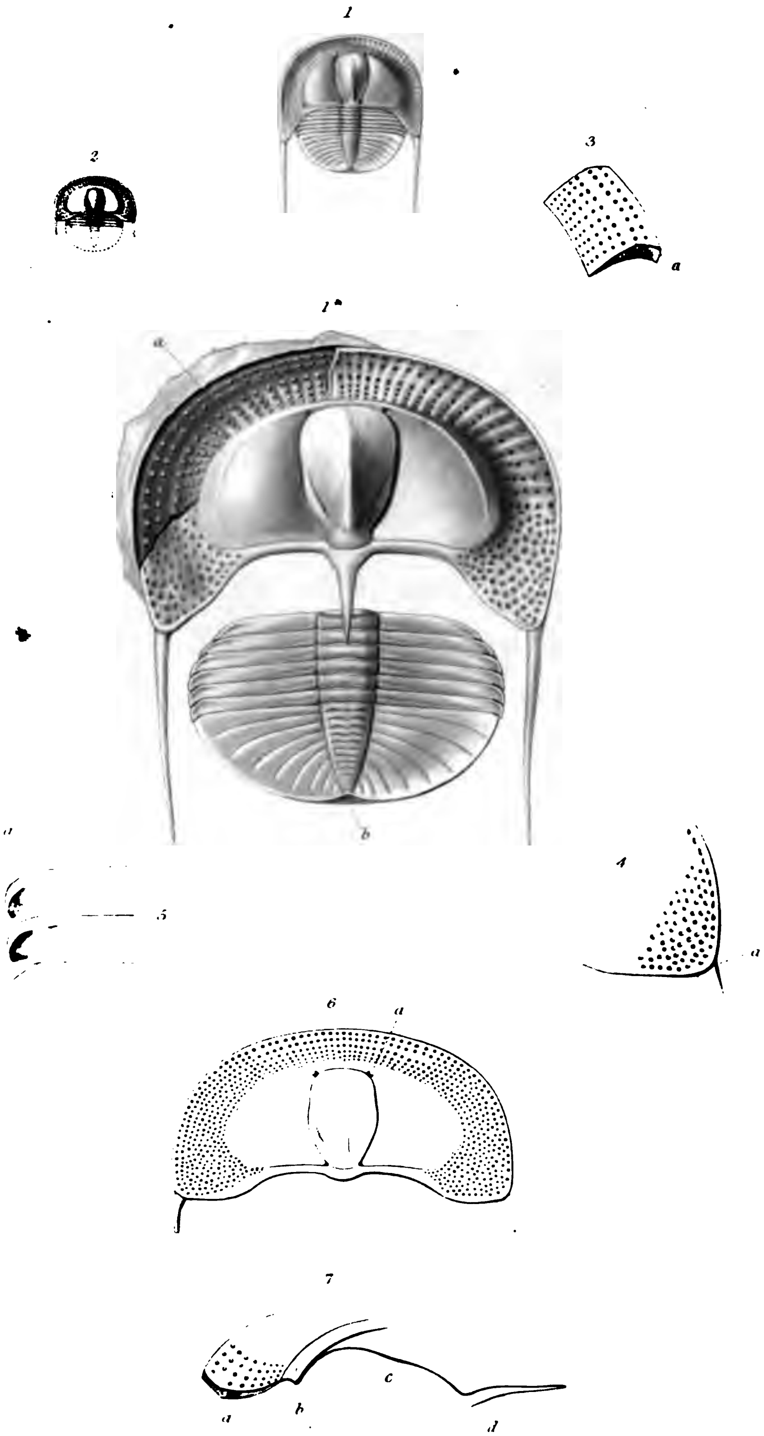
* Ofversigt Köngl. Vetenskaps Akad. (1845), 109, pl. 2. f. 2.



TRINUCLEUS LLOYDII. *Murchison.*

Fig. 3. Portion of the under surface of the fringe, magnified, showing the wide space between the second and third rows of pores, and at *a*, the thick flattened edge. The fringe is hollow, and its substance very thin.

Fig. 4. The posterior angle, magnified; a raised edge, *a*, separates the fringe from the spine; the latter is often broken off at this point.

Fig. 5. Extremities of two thorax rings, with strong indentations; *a*, fulcral point.

Fig. 6. Head of fig. 2, magnified. At *a*, the indentations (for the attachment of the hypostome?) on each side is shown.

Fig. 7. A section of the head and fringe, viewed rather from the upper side; *a*, the concavo-convex fringe; *b*, the narrow raised ridge between the fringe and the moderately convex glabella *c*; at *d* the cervical spine is shown.

All the specimens in the Mus. Practical Geology.

The name of this genus can only be retained by general consent, for the typical species was formerly denominated *Cryptolithus*, and sufficiently described by Green; and had, indeed, received the name *Nuttainia* a few months earlier in the "Geological Text Book" of Eaton, the American geologist. But in this case strict priority may be allowed to yield to classical feeling,—the name *Trinucleus*, a strictly appropriate one, having been used in one of the earliest figures given of these or any trilobites, viz., in Dr. Llhwyd's paper in the Philosophical Transactions for August 1698. The '*Trinucleum fimbriatum*,' there figured, along with other trilobites, is the common Llandeilo species, now called *T. concentricus* or *T. Caractaci.*

In a short communication to the Geological Society, read March 1847, I endeavoured to explain the structure of the peculiar fringe of this genus, which had been beautifully figured just before by M. Rouault. However irregularly scattered the pores may seem in some of the species, they can generally be traced as arranged in radiate lines; in *T. radiatus* and *T. fimbriatus* very strikingly so indeed.

If these holes were elongated in the direction of the radii, so as to coalesce with each other, the intervening ridges would become hollow spines standing out from the head margin, and we should then at once recognize them as identical in structure with the marginal spines so characteristic of *Acidaspis*, and a few other genera. On the other hand, in the genus *Harpes*, not yet published in these Decades, the separation of the expanded fringe has not proceeded so far as in *Trinucleus*, the puncta in that genus not even piercing through the fringe, but only impressed upon it.

This genus, like so many others, is now ascertained to undergo metamorphosis, at least so far as increase in the number of thorax rings is concerned, M. Barrande having found the common species with from 0–6 body rings; and a specimen of it with four rings furnished M. Corda with materials for the foundation of his genus *Tetrapsellium*, a name which must of course be cancelled. The late division of the genus by Professor M'Coy into *Trinucleus* and *Tretaspis*, depends partly on this accidental circumstance; but the group *Tretaspis* will form a convenient sub-genus, distinguished by the other characters he has pointed out,—the glabella furrows, the more distinct ocular tubercle, and facial suture, &c.

Trinucleus frequently occurs in a rolled-up form, as figured by Beyrich and Rouault. The genus appears to us strictly Lower Silurian; the specimens said to have been obtained from Wenlock Shale are not yet well authenticated.

SECTION I. TRINUCLEUS proper.

1. *T. Lloydii.* Above described.

2. *T. concentricus*, Eaton. *Trinucleum fimbriatum vulgare*, Llhwyd (1698), Phil. Trans., v. xx. tab. add. f. 9. Ichnogr. Brit. (1690), tab. 23. at top. *Trilob.* Brongniart, Crust. Foss., t. 4. f. 6, 7. Bigsby, Ann. Lyc. Nat. Hist. New York, 1824, vol. i. pl. 15. f. 1. *Nuttainia concentrica*, Eaton, Geol. Text Book (1832), pl. 1. f. 2. Hall, Pal. New York (1847), pl. 65 and 67. *T. Caractaci*, Murch. Sil. Syst., pl. 23. f. 1. *Ampyx* (*Cryptol.*)

Caract., Emmr. (1839), Diss. 51, bona. *A. tesselatus*, ib. 50. *T. ornatus*, Salter, Quart. Geol. Journ. (1847), v. iii. 253. (including all synonyms); Mem. Geol. Surv., v. ii. pt. 1. pl. 9. f. 1, 2. *T. Caractaci* and *T. gibbifrons*, M'Coy, Pal. Foss. Woodw. Mus., pl. 1 E. f. 14. *T. Goldfussii*, Barr. (1853), Syst. Sil. de Böhême, pl. 30. f. 29–40. *T. ornatus*, ib. f. 41–60.

—*Junior* (four body rings). *Tetrapsellium pulchrum.* Corda, Prodr., f. 18. [mala].

T. ovatus latus, fere rotundus, fronte subangulato, glabellâ obovatâ genis paullo longiore, gibbâ, nec lobatâ, fimbria subtùs angulatâ insuper planâ, interdum lentè concavâ, poris crebris quincuncialiter dispositis aut oblique radiatis, in ordines 4–5 concentricos (ad frontem sæpissime interruptos) collocatis; alis modicis, spinis longis divergentibus; cervice spinifero; caudâ thorace breviore, axi convexo ad apicem lente decurvo, lateribus paullo concavis radiatim 5–6 sulcatis, margini abrupto declivi.

There are three if not four principal varieties of this variable species, the differences mainly consisting in more or fewer rows of pores being continued round the front, and the glabella being sometimes as broad as the cheeks and sometimes narrower. But the differences are by no means enough to separate them as species. Variety δ, indeed, differs so much that if it were not for intermediate specimens, it would be difficult to believe it the same. A trifling alteration is necessary in the arrangement of the varieties from that given in the Quart. Geol. Journ. vol. ii.

Var. β. *Caractaci.* Murch. l. c.

—*punctis crebris approximatis, ad frontem in ordines 4 continuos dispositis, glabellâ latâ.*

Localities.—Welshpool; Dinas Mowddwy and Bala, North Wales, in Bala Rocks.

Var. ε. *Portlockii.* Salter.—*T. Caractaci* and *T. latus*, Portlock, l. c. pl. 1 B.

—*fimbriâ angustiore, punctis ad frontem subradiatis et in ordines 3 contractis; glabellâ subclavatâ genis paullo angustiore, caudâ brevi.*

Localities.—Tyrone; Desertcreat; passing insensibly into the next variety.

Var. γ. *elongatus.* Portlock, l. c. f. 7.

—*fimbriâ angustâ, punctis ut in præcedenti; glabellâ angustâ clavata; caudâ longiore, apice nec decurvo.*

The lateral ribs of the tail are very distinct in this variety, the elongation of which is not entirely due to pressure and cleavage; several specimens present the same characters; the whole axis is narrower, the tail longer, and with a raised margin; the lateral ribs, 6 or 7, very distinct; the apex not decurved, but rather elevated. We think it merely the male of it.

Locality.—With the last, Tyrone.

Most of the Bala, Llandeilo, and Pembrokeshire specimens have the fringe with only three puncta in front, and the glabella short, broad, and gibbous; they agree perfectly with *T. concentricus*, and help to establish the passage into the next variety.

Llandeilo and Pembrokeshire varieties, with narrow glabella, and the puncta in somewhat sunk short radii in front, but with the upper angles of the fringe not expanded, connect the above varieties with—

Var. δ. *favus.* Salter, Mem. Geol. Surv. l. c. pl. 9. f. 3.

—*capite transverso, rectangulari, fimbriâ angustâ antice punctis paucis radiantibus; angulis externis quadratis, poris magnis favosis; glabellâ elongatâ.*

Of this curious variety some have the angles more expanded than others. Where the enlargement of the pores takes place the fringe is also convex, and the appearance is just that of honeycomb.

Localities.—Narberth, &c. in Pembrokeshire; also Llandeilo; Middleton, near Chirbury, Shropshire.

Var. α. *Goldfussii*, Barr. (*Sternbergii*, Salter, Geol. Journ. l. c.) is the *Trinucleus* so frequent in the sandstones of Bohemia. It differs little from var. β, except in having closer pores. Specimens of equal size with ours would scarcely differ at all. *T. ornatus*, Sternb., has the pores more remote, and is much more like the common Bala forms which are intermediate between var. β and ϵ. It has long and curved spines, a character which our British specimens are never perfect enough to show. Hall's *T. concentricus* shows similar variations in the fringe as ours do, but the tail in his figures is made too blunt. We have it from the Hudson River group, of the usual short subtriangular form.

There is no end to the variety of names under which this fossil has passed. It appears, from Hall's account in the "Palæontology, New York, 235, note," that *Nuttainia concentrica* is the oldest name, having been published in Eaton's Geological Text Book in 1832, and forming the type of his genus. Green's name, *Cryptolithus tesselatus*, though published the same year, was subsequent to it. Sternberg's name, *T. ornatus*, not being put forth till 1833, must give way, and if we have not yet got at the earliest name, we must be ready to change it again. However, as Hall was the companion of Eaton, and collected the very specimens described, his decision must be considered final; and the name *Trin. concentricus* must be applied for the future to this cosmopolite fossil. If we were to go back to Llhwyd's name, certainly the earliest of all, it should be *T. fimbriatus*; but that would be contrary to rule, and only create confusion.

In the Quarterly Geol. Journal, vol. iii., p. 253, I have endeavoured to combine the synonyms of the species; and I see no reason to alter the nomenclature there proposed. I had not then observed that Beyrich had, a year before, suggested the union of *T. ornatus* from Bohemia with the British fossil; but this was from figures only.

Localities.—North and South Wales; everywhere in Llandeilo and Bala Rocks; Horderly and Cheney Longville in Caradoc sandstone; Caradoc shale, banks of the Onny, near Cheney Longville (Sedgwick). Lower Silurian Rocks of Tyrone, Wexford, and Kildare, Ireland; not yet in Scotland.

Foreign Distribution.—North America and Canada. Bohemia. Not yet found in France or Spain, where its place seems to be taken by *T. Pongerardi*, Rouault. Nor is it found in Sweden, where *T, seticornis* is plentiful.

3. *T. Thersites.*—sp. nov.

T. capite lineas 4 lato, semicirculari, fronte paullum anguluto, glabellâ genis depressis longiore angustissimâ valde elevatâ et acuticarinatâ; fimbria angustâ, planâ nisi lineâ medianâ paullo incrassatâ, punctis satis crebris nec radiatis in ordines tres concentricos collocatis; cervice brevispinoso; sulco verticali distincto, sub genis latiori; angulis posticis haud expansis, spinis——?

The second or middle row of pores on the fringe is more distinct than the others, on account of the slight swelling of the fringe along that line; and at the angles a few pores are interspersed between this row and the cheeks. The remarkably elevated and carinated glabella easily distinguishes this species, which has remained long in our collection, indicated as an undescribed *Trinucleus* in Professor M'Coy's Mss.

Locality.—Tramore, Waterford; in Lower Silurian slates.

Section II. TRETASPIS, M'Coy.

Ocular tubercle distinct; eye-line cutting the posterior margin, but the head not separable at the sutures; glabella lobed.

4. *T. seticornis*, Hisinger (*Asaphus*), Leth. Suec., t. 37. fig. 2. *A. cyllarus*, ib., fig. 3. *T. seticornis*, Lovén, Ofvers. Kongl. Vet. Akad. (1845), t. 2. fig. 1. Portl. Geol. Rep., pl. 1 B. fig. 8. *T. radiatus*, ib., fig. 9. *T. Bucklandi*, Barr. (1846), Not. Prelim. 31. id. Syst. Sil. de Böhême (1853), pl. 30. f. 14–16. *Tretaspis setic.*, M'Coy (1851), Pal. Foss. Woodw. Mus. 147.

T. ellipticus, corpore plano, oapite convexo reticulato; glabellâ genis longiore clavatâ antice inflatâ utrinque 2–3-sulcosâ; fimbriâ undique deflexâ, insuper convexâ, margine recurvo incrassato, subtus planiore; poris in ordines 5, 6 collocatis, radiantibus; angulis posticis longispinosis, spinis rectis parallelis; caudâ brevissimâ rotundatâ, lateribus lævigatis, margini lato declivi.

The fringe is always steeply bent down, and follows the declivity of the cheek without any change of direction, except in some specimens a gentle convexity. The pores are in 6 rows (5 in younger specimens), of which the outer two are placed close together in the deep furrow immediately before the thickened striate margin. The concentric rows are more distinct than the radiating ones in Bala specimens,—in those from Haverfordwest and Ireland the radiation is more manifest. The specimens from the latter locality show the same reticulate character of surface of the head which is seen in our next species. This structure is but rarely to be seen in our other specimens,—nor can we find it at all in two from Sweden in the collection of the Geological Society. Perhaps it is easily abraded; the specimens agree in all other respects.

Localities.—Lower Silurian. In Ireland; Desertcreat, Tyrone; Chair of Kildare; Newtown, Wexford. In Wales; Bala; Llanfyllin; Haverfordwest, &c.; chiefly in limestone strata.

Foreign Localities.—Lower Silurian. Dalecarlia. Kœnigshof, Bohemia (Barrande.)

5. *T. fimbriatus*, Murchison, Sil. Syst., t. 23. fig. 2 (head only.) *Ampyx* (*Cryptolithus*) *fimbriat.*, Emmr. (1839), 52. (not of Portl.) *Tretaspis*, M'Coy, Pal. Foss. 146. pl. 1 E. f. 16.

T. latè ovatus depressus, capite truncato, undique reticulato-punctato; glabellâ convexiusculâ, genas longitudine æquante sed angustiore, utrinque sulcis tribus brevibus; fimbriâ subtus concavâ; insuper primum planâ radiatim sulcatâ, deinde angulatim deflexâ; parte planâ radiatim sulcatâ, poris in utroque sulco 4; parte externâ ad marginem singulo pororum serie ornatâ; angulis capitis haud expansis, spinis brevibus tetragonis divergentibus; thorace abbreviato; caudâ thorace breviore, subtriangulatâ, lateribus læviter 5-costatis, margini declivi.

A specimen of this species in the young state, 2 lines long, has been found with only 5 thoracic segments; it however soon attains the full number. The head is very wide: the fringe is very regular in width round the head, and not invaded at all in front by the glabella as in the last species. It is flat and deeply marked for the first half with sunk radii, full of close-set pores, then rather abruptly deflected and furnished with but a single row on the outer portion.

The tail figured on the same slab with the head of this species in the Sil. Syst. belongs to *Ampyx nudus*; and Burmeister has described it as belonging to the present species; the true tail is short and few-ribbed, as in all the other *Trinuclei*.

Localities.—Only yet found at Builth in Radnorshire; it is exceedingly abundant in the lane leading to the farmhouse called Pen-Cerrig, on the west side of the hill, where it occurs with *Ampyx nudus* and *Agnostus M'Coyii*, (*A. pisiformis*, Murch.)

6. *T. radiatus*, Murchison, Sil. Syst., t. 24. fig. 3. *Ampyx*, Emmr. l. c. 52. (not of Portlock, Geol. Rep., nor of M'Coy, Pal. Foss. 146).

T. paullo adhuc cognotus; præcedenti simillimus, nisi angulis superioribus capitis expansis multipunctatis, glabellâ longiori.

Except in the expanded upper angles of the fringe, which consequently contain at this part many more pores in a row, this does not appear to differ from the last species. The style of the fringe is exactly similar, and the pores placed in furrows in the same way.

The enlarged angles are the chief character, but in some specimens of *T. fimbriatus* there are slight indications of this. As *T. concentricus* varies in this respect it is not too much to suppose *T. radiatus* to be a variety in the same way. The spines, however, are less divergent, and the fringe is invaded in front by the glabella, which too is longer in proportion. In this species not all the pores appear to penetrate the fringe; the outermost and innermost certainly do; the intermediate ones, if they do pierce through, are smaller.

Locality.—Trilobite Dingle, Welshpool [Sir R. I. Murchison.] Coll. Geol. Society.

J. W. Salter.

August, 1853.

BRITISH FOSSILS.

DECADE VII. PLATE VIII. Fig. 1.

REMOPLEURIDES COLBII.

[Genus REMOPLEURIDES. PORTLOCK. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Body attenuated behind; glabella circular, occupying the greater part of the head, with an abruptly produced front; its sides closely encircled by the very long smooth eyes; eye line ending posteriorly close to the axis; cheeks small, produced into spines; hypostome truncate in front; body segments 11, the 7th or 8th with appendages, the axis broad, the pleuræ falcate; tail minute, the axis very short, of 2 or 3 segments, the border spinose [4 spined.] *Caphyra*, BARR. *Amphitryon*, CORDA.]

[Sub-genus *Remopleurides*. Glabella furrows quite obsolete.]

DIAGNOSIS. *R. longi-ovatus; glabellâ maximâ, quam longâ latiori, ad frontem inter oculos angustâ; genis parvis, in spinas breves divergentes extensis; thoracis axi latissimo, anterius fere pleuram ter superante; pleuris brevibus (septimo haud producto?) fulcro ad axin appresso, in tuberculum longum valde protenso; caudâ subquadratâ, axi abbreviato biannulato,* [*margine quadrispinoso, spinis externis brevioribus.*]

SYNONYMS. *Remopleurides Colbii*, PORTLOCK (1843), Geol. Rept., Tyrone, 256, pl. 1. fig. 1. *R. Kolbii*, EMMRICH (1845), Neues Jahrb. 45. M'COY (1846), Syn. Carb. Foss. Irel. 43.

The fortunate discovery by Lieutenant-Colonel Portlock of three or four species of this most remarkable group, enabled its discoverer at once to establish it as a new genus, allied to *Olenus* and *Paradoxides*, a relation borne out by many points of its structure. A more perfect specimen, since found in Ireland by the Geological Survey, enables us to supply some points left doubtful in his descriptions, and we have figured afresh three of his original specimens to illustrate a suggestion thrown out by him, that the variations in proportion observable in these closely allied species may be sexual rather than specific characters. New species have been discovered both in Britain, Sweden, and Bohemia, but except in these countries the genus is not yet known.

Description.—An inch long, and five and a half lines wide, generally convex, of a long ovate form, blunt and rounded in front, narrow and pointed behind. The head occupies not quite one third of the length, and is considerably wider than the body; it is chiefly composed of the large, smooth and convex glabella, which is widely urceolate, the sides strongly arched outwards, so as to form a transverse broad oval, exclusive of the produced and narrow tongue-like front. The produced front is broken off in this specimen, but doubtless existed, as in the other closely allied species; we have indicated its shape by dots. This contraction of the glabella in front, so characteristic of the genus, is due to the excessive prolongation of the eyes, which would meet in front, but for this narrow projection. They completely encircle the sides of the glabella, separated from it only by a narrow rim or eye lobe, and extend their course backwards into the neck furrow, approximating below as they do in front, and indenting a little the base of the glabella. The eyes are of equal width throughout, and are smooth externally, but when decorticated show a closely facetted surface. They are subtended by a raised border along their lower edge.

The wings or free cheeks are small and subtriangular, extending at least as far as the eyes do in front (see fig. 1, *a*); they are striated, have no distinct border, and are prolonged behind into a short and slender spine, which is directed a little outwards, and reaches as far as the third body segment. The eye line is not traceable in front, behind it runs, as in all the genus, vertically beneath the eye, and consequently ends close to the axal furrow. The neck segment is not quite so broad as those of the body, and is separated from the glabella by a sharp furrow.

[At fig. 5, we have represented the hypostome either of this or of one of the two following species. Colonel Portlock has figured this specimen in a reversed position,* as possibly the internal cast of the head; but it is clearly an hypostome, and a comparison of its characters with those of another species of Remopleurides, figured by M. Corda in his work on Trilobites, pl. 6. fig. 58, enables us without doubt to refer it to this genus. From its size it is probably that of one of the three species represented on our plate; and it was found at the same locality with them in Tyrone.

It is four lines broad, and two lines high, nearly rectangular, with the base very broad and quite straight, and its outer angles elongated; it then contracts a little in width, and is strongly notched on the side just before it again suddenly expands to form the broad truncate tip; the front edge is very slightly sinuous. The points of the front angles are broken off, but they appear to have been produced laterally rather than decurved, in which they differ from those of fig. 6. A narrow, but distinct sulcus all round distinguishes the central more convex portion, which is straight at the upper or basal margin, but semicircular in front. A slight prominence rises on the middle of the upper margin, on each side of which strong imbricating striæ descend and meet V fashion along the median line. They extend only along the upper edge, and beneath them fine vertical striæ arise, and cover nearly all the rest of the central space. Concentric striæ run round all the margin, both on the front and sides, and the latter are also marked by a flexuous keel which follows the curve of the lateral notch.

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* Report, Tyrone and Londond., pl. 24. fig. 10. p. 470.

Fig. 6, a specimen from Waterford, where the *R. dorsospinifer* occurs with it, differs very little in size or outline; it has the flexuous keel and notch on the sides, and the expanded angles of the base and apex. But the latter, instead of being extended outwards (as they appear to do in fig. 5), curve down and forwards, forming short falcate lobes *b*, *b*,—the front margin is a little more sinuous. The specimen is more compressed, and the central portion therefore less convex, though of the same shape. The large imbricating striæ too are not preserved. The differences above pointed out are, however, very trifling; and we believe both are of the same species, fig. 5 having the falcate lobes broken off.]

Body segments 11; the axis is convex, and very broad, and in front nearly three times the width of the diminutive pleuræ; posteriorly it is narrowed to one third of its width in front, and in the last segment is not quite twice as broad as the pleuræ, which diminish but little as they recede from the head. The seventh pleura on each side is broken; but enough remains to show that it was not in this specimen materially larger than the rest. All are short, falcate, directed backwards and downwards, with a very short oblique furrow, and furnished on the forward edge close to the axis, with a strong projecting fulcral tubercle; the hinder edge with a corresponding deep notch, the margin of which is raised all round. The pleuræ are striated obliquely. The segments of the axis are crossed by tranverse lines, and covered with faint tubercles; a row of strong tubercles along their hinder edge gives a serrate margin to each segment. There is no appearance of any enlargement of the eighth segment of the axis. Tail squarish, wider in front than behind; the axis short, its length less than half that of the tail, composed of two joints, an upper ring, which is very narrow in the middle and is produced downwards at the side, and a rounded terminal joint. On the forward edge, and close to the axis on each side, is a strong and prominent fulcral tubercle like those of the pleuræ. The flat limb terminates in four rather short teeth all directed backward, the two lateral ones, though nearly equal in size with the others, not being produced so far back. These teeth are broken off in the specimen figured, but the description is taken from well preserved specimens found in North Wales, and apparently of the same species; the surface of the limb and of its teeth is finely striated across with close waved lines.

British Localities and Geological Position.—Lower Silurian; Desertcreat parish, Tyrone, in argillaceous schist, fig. 1. Bala limestone, North Wales.

REMOPLEURIDES LATERISPINIFER.

Fig. 2.

Diagnosis. *R. longiovatus, glabellâ maximâ quam longâ latiori, ad frontem inter oculos angustâ; genis parvis, in spinas breves extensis; thoracis axi latissimo, anticè pleuram ter et plus superante, pleuris brevibus, septimo utrinque longè producto, fulcro appresso elevato; caudæ axi abbreviato biannulato; (margo omnino caret, ut in præcedenti habendus.)*

Synonyms. *R. laterispinifer*, Portlock (1843), l. c., pl. 1. fig. 2. M'Coy (1846), Syn. Carb. Foss. Irel. 43. Corda (1847), Prodr. Böhm. Tril., 113. t. 6. fig. 59 [mala].

Description.—Length fourteen lines, width eight lines. The general shape and convexity, the size and form of the glabella, cheeks and eyes, are the same as in the preceding description. But the head is rather more than one third the whole length of the body, and the width of the tongue-like front of the glabella (which could not be accurately determined in the foregoing species), is somewhat less than half that of the entire glabella.

The axis of the body is in front nearly four times as wide as the short pleuræ, in the last ring it is only one third of this width, and about twice the width of its pleura; its segments are each tuberculate along their hinder edge, as in the last species, and show some faint traces of granulation over the surface; the seventh pleura on each side is abruptly lengthened and produced backwards (not so much outwards as in our figure) as far as the origin of the tail. In all other respects the body rings agree with those of the *R. Colbii.*

The tail is broken, and has lost all but the anterior margin and the axis; the latter is of two rings, and their shape is as in the last species. Immediately beneath the axis there is an emargination like that represented in Portlock's figure; but it is, I believe, a fold of the incurved under portion, and is certainly not a part of the margin of the tail, which indeed, from the proportions of the fragment left, would have been of just the shape of that of *R. Colbii.*

British Locality and Geological Position.—LOWER SILURIAN. Townland of Bardahessiagh, Tyrone, in micaceous sandy schist.

REMOPLEURIDES DORSOPINIFER.

Figs. 3, 4.

DIAGNOSIS. *R. elongatus longiovatus, glabellâ maximâ quam latâ longiori, ad frontem inter oculos angustâ; genis parvis, in spinas breves extensis; thoracis axi latissimo, anticè pleuram ter superante, segmento octavo incrassato, in spinam fortem extenso; pleuris brevibus, fulcro ut in præcedenti; caudæ margini quadrispinoso, spinis externis brevioribus.*

SYNONYMS. *R. dorsopinifer*, PORTLOCK (1843), l. c., pl. 1. fig. 3. also fig. 4. M'COY (1846), Syn. Carb. Foss. Irel. 43.

Description.—Length one inch. The general shape is more elongated than in the two foregoing species, and the anterior produced portion of the glabella is scarcely more than one third its entire width; otherwise the proportions of the head and its parts are very similar. The body rings, except in the narrower axis, agree in structure with those of *R. Colbii*, and *R. laterispinifer*; the rings of the axis have their posterior edge serrated, and their surface granulose; and the pleuræ are similar in shape, and in the position of the fulcrum. The chief difference is in the comparative width of the axis, which is not three times the width of the pleuræ in front, and posteriorly is not so much narrowed, being little less than half the width it has in the anterior part. The seventh pair of pleuræ, too, are not at all elongated, at least not in the young and perfect specimen, fig. 4 (in fig. 3, Portlock's original specimen, this portion is broken off). The eighth segment of the axis is incrassated, and gives birth to a short spine which extends backward, lying closely on the segments, nearly to the end of the tail; the tip of the spine is a little recurved, and its surface striated. The incrassation of the eighth segment is only seen in the exterior crust (fig. 4, *a*); the interior cast of the same segment (see figs. 3 and 4) shows nothing of it. The tail is oblong, the posterior edge cut into four strong teeth, the two outermost shorter than the others. The axis two-ringed, as in the other species.

British Locality and Geological Position.—LOWER SILURIAN; Desertcreat parish, Tyrone (fig. 3.), in fine micaceous sandy schists; Tramore, Waterford (fig. 4), in arenaceous slate.

Variations.—These three supposed species have purposely been described and figured together, in order to show how very trivial the variations are between them, except, of course, in the remarkable appendages to which the specific names refer. *R. laterispinifer* has the general axis somewhat broader than *R. Colbii;* and this again than *R. dorsospinifer*. The two first-named species, indeed, agree very nearly in its proportions, as it tapers in the body segments rapidly from front to back. In the last form, which is more elongate and narrow than either, this tapering is not nearly so rapid. But the general shape, configuration of the glabella and cheeks, the extent, size, and position of the eyes, the broad axis of the body rings, and the short hatchet-shaped pleuræ, are the same in all; each has the remarkable produced fulcral point, placed close to the axis—and the tail, as far as it is preserved in each species, shows no difference in character. The surface, too, appears granulose in all, and the posterior edge of the body segments is serrated by a projecting row of tubercles.

The only striking peculiarities reside in the appendages, the first having neither lateral or dorsal spines; the second having the seventh pair of pleuræ produced into spinous points; and the last, together with a more elongate general form, is furnished on the eighth segment of the axis with a strong dorsal spine.

Sex.—How far these variations may be regarded as differences of sex, is a point worthy of consideration. It is well known that a narrower form, and additional ornament frequently characterizes the male of other Crustacea. In the former Decade we have endeavoured to apply this to the observed differences between certain species of *Phacops,*—and in the present one to *Cyphaspis.*

M. de Barrande has, indeed, shown that there generally exists among the Bohemian Trilobites a broad and narrow form of each species; and he has particularly noticed this in the case of *Acidaspis* (*Odontopleura*), and considered the narrower form that of the male.

He also mentions a variation in the number of spines, but this does not appear to be connected with the variation in form. We are not, therefore, yet warranted in supposing that very considerable difference in the appendages may be referred to sex. It is, however, we think, allowable to look for independent characters in a group that has no exact living representatives. Burmeister has shown us that we cannot tell at what segment of a trilobite's body the thorax really terminates, as that is determined by the position of the generative pores. But, as it is extremely likely this should have some external mark, we venture to suggest that the seventh or eighth segment in this genus is the point where the thorax terminates and the true abdomen begins.

Unfortunately, among those Entomostraca most nearly allied to Trilobites, we have not instances of such variation. The sexes of Apus do not appear to differ much externally, and in Limulus a notch in the front part of the shield of the head, and some trifling differences in the feet, are all that mark the male.

But if we turn to the *Isopoda* we have a direct analogy, at least in one group. In *Serolis*, it is true, there are but slight differences in the feet, the external form remaining the same. But in several species of *Sphæroma*, *S. armata*, &c., the last or last but one ring of the thorax is prolonged into a spine, very like that on the fossils; and in one species, *S. diadema*, if not in others, it is the characteristic mark of the male; in the female it is absent, or reduced to a mere tubercle.

Without, therefore, prematurely attempting to alter the nomenclature applied by their discoverer, I may state it as my belief, that in the *Remopleurides dorsospinifer* may be recognized the narrow form and dorsal spine of the male; in *R. laterispinifer*, a mature broad female form, with the eighth pair of pleuræ dilated as ovigerous supports; *R. Colbii*, which is intermediate in form, and destitute of these appendages, I would suggest to be the immature female; and should further observation confirm this view, the species should be re-united under the name of *R. Colbii*.

Affinities.—*R. longicostatus*, Portlock, of which we have given the characters further on, differs at a glance from each of the foregoing species, not only by the great width between the eyes in front, but by the narrow body axis, which is scarcely wider than the large falcate pleuræ. This is the only species with which they can be compared; for the *R.* (*Caphyra*) *radians* has the glabella strongly marked by three segmental furrows on each side, and belongs to a different section of the genus. *R. platyceps*, M'Coy, besides having a glabella (the only part known) considerably wider, which might be due to pressure, has this portion tuberculate, as I found by examination of the original specimen, in 1845.

History.—Very little has been contributed to the history of these species since Col. Portlock's account, for the simple reason that the species are very rare in Britain, and have not yet occurred in other countries; and the author himself did not clearly make out either the number of body rings or the structure of the tail, and he overlooked the eyes. The genus was at once admitted in the classification proposed by Dr. Emmrich in 1845, and placed at the end of the Olenoid group; but the number (12) of body rings proposed there, although an improvement upon Col. Portlock's enumeration (who included the neck segment and the first of the tail) was erroneous, and the distinction between it and *Olenus* very obscurely defined, owing chiefly to the original mistake about the eyes. M. Corda, too, in his general descriptions and figures of the Trilobite genera, corrected the description of the eyes in *Remopleurides laterispinifer*, which he, however, represented with thirteen body rings and a bifurcate tail. A closely allied species from Bohemia is there more correctly figured and described. The genus appears to be entirely Lower Silurian.

EXPLANATION OF PLATE VIII.

Fig. 1. ***Remopleurides Colbii.*** Col. Portlock's original specimen, Tyrone; and the same magnified, and dissected; in fig. *a*, the left free cheek or wing is represented as separate, but it is not known whether the wings were connected in front—the front portion of the head is restored in dotted lines; at *b*, the 3d or 4th thorax segment showing the prominent fulcra * *; at *c*, the 7th segment, the broken pleuræ appearing not to have been produced into spines; at *d*, the last segment; *e*, the tail, its serrate edge restored from better specimens; *f* shows the striated external surface, and the groove and fulcrum of two of the pleuræ. Several portions of the crust are preserved in this specimen.

Fig 2. ***Remopleurides laterispinifer.*** The original specimen; an internal cast only; at 2 *b*, the 7th and 8th thorax segment magnified; at 2 *c*, the broken tail; the outline restored in dots.

Fig. 3. ***Remopleurides dorsospinifer.*** Original specimen; at 3 *c*, two of the thorax segments in the front pleuræ, internal cast, showing the grooves deeper than in fig. 1 *f*; 3 *d*, the 7th and 8th segment of the axis, the latter with the long dorsal spine.

Fig. 3 *a*, 3 *b*. Two views of the head of another specimen, same locality; also figured by Portlock.

Fig. 4. A young perfect specimen, Tramore, Waterford; somewhat elongated by cleavage; 4 *a*, 8th and 9th thorax segments, external surface; 4 *b*, internal cast of the 8th, showing no enlargement; 4 *c*, the perfect tail, magnified.

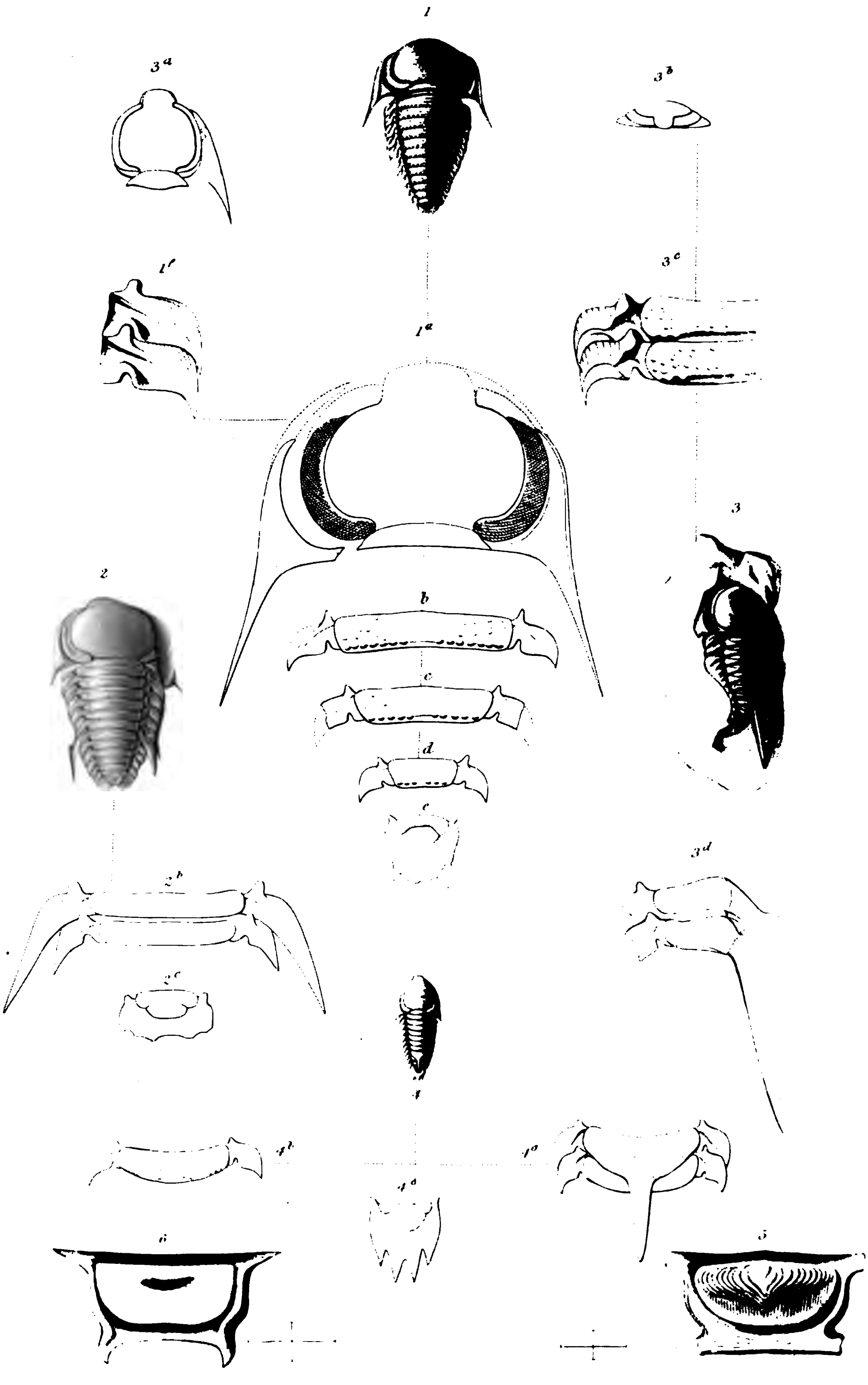

Fig. 1. REMOPLEURIDES COLBII *Portlock.* *Figs. 3, 4.* R _ _ DORSOSPINIFER *Portlock.*
2. R LATERISPINIFER *Do.* *5, 6.* Hypostome of Remopleurides

Fig. 5. Hypostome of a species of *Remopleurides*; in all probability of one of the above species, with which it is associated in the rock; it shows the lateral indentations, but not the projecting outer angles; they appear to be broken off. Desertcreat, Tyrone.

Fig. 6. Probably the same species, from Tramore, Waterford; the lateral notches and projecting outer angles are very perfect.

Other British species of the Genus.

SECTION REMOPLEURIDES. Glabella furrows quite obsolete.

Sp. 4. *R. platyceps*, M'Coy, Synopsis Sil. Foss. Ireland, p. 44.

R. glabellâ (adhuc solum cognotâ) ut in præcedentibus, sed bis quam longâ latiori, tuberculatâ.

Locality.—Carrickadaggan and Greenville, Enniscorthy, county Wexford (M'Coy), in Lower Silurian rocks.

5. *R. longicostatus*, Portlock (1843), Geol. Rep. Tyrone, pl. 1. fig. 6. *R. longicapitatus*, ib. fig. 5.

DIAGNOSIS. *R. ovatus, glabellâ undique lineatâ magnâ rotundatâ, nec totum capitis latâ, quam longâ latiori, ad frontem inter oculos latâ; genis modicis triangulatis, in spinas longissimas paullo incurvatas extensis; thoracis axi postice attenuato, anticè nec pleuram bis excedenti, segmentis octo primis inermibus (reliqua absunt); pleuris satis longis falcatis, nunquam productis, fulcro proximo elevato.*

This fine species, with a rounded form of glabella, somewhat like the foregoing species, has the eyes much less extended forwards, the portion between being very large and broad. The pleuræ too are as wide as the axis, or nearly so, and the long head spines are produced backwards at least as far as the 8th body segment; beyond this, the specimen is imperfect. Fine wavy lines cross the glabella, and by these even portions of the head may be distinguished from the *R. Colbii* and its allies, which all appear to have this part smooth. *R. longicapitatus*, from the same locality, is a glabella only, somewhat elongated by lateral pressure; it agrees in all the other characters with the present species.

Localities.—Tirnaskea, Tyrone, in sandy schist; Tramore, Waterford, in dark slate; Chair of Kildare, county of Kildare, in limestone. LLANDEILO or BALA BEDS.

Sp. 6. *R. obtusus*, sp. nov.

R. parvulus, glabellâ lyratâ subconvexâ elongatâ, anticè latissimâ, oculis abbreviatis vix curvatis; thorace (segmentis primis) pleuris læviter sulcatis axi paullo angustioribus, fulcro haud eminente nec ad axin appresso.

Although imperfect, this is evidently quite distinct from any of the rest; the obtuse and wide front of the glabella and the consequently reduced size of the eyes readily distinguish it. The glabellar furrows are only just indicated, if at all existing. The fulcral segments are remarkable, for the fulcrum, instead of being strong and projecting, and placed close to the axis, is at some little distance from it, and does not project more than in ordinary trilobites.

Localities.—Desertcreat, Tyrone. [Survey Coll.]

SECTION II. CAPHYRA.

Glabella moderate, not inflated, with three pairs of furrows.

Sp. 7. *R. (Caphyra) radians. Caphyra radians* (glabella solum). Barrande, Notice Prelim. Syst. Sil. Bohême, p. 32. (1846). Sil. Syst. Bohême, 1853, pl. 43. fig. 33-39. *Amphitryon Murchisonii*, Corda (1847), Prodr. Böhm. Tril., t. vi. f. 58.

R. sesquiuncialis (in exempl. Brit.) *depressus, ovatus, glabellâ late urceolatâ, quam longâ latiori, antice angustissimâ; sulcis sursum curvatis, nec marginem attingentibus; oculis longissimis; genis dilatatis, angulis in spinas latas extensis; thorace segmentis* 10, *pleuris falcatis, fere axin convexiorem æquantibus, fulcro proximo; caudâ longâ, quadrispinosâ, spinis externis longioribus.*

M. de Barrande, when in England, agreed with us in identifying this species; and we adopt the above specific name, believing it to be but common courtesy, when correcting the mistake of a careful and judicious author, to retain the name he imposed. M. de Barrande, it is true, described as a tail the reversed glabella of this species, but he carefully distinguished it from all other Bohemian trilobites; and M. Corda has conferred no advantage on science in changing both the genus and species, although he had fortunately obtained a perfect specimen. He has figured the eyes much too short; they curve round the glabella, and nearly meet in front, as may now be well seen in the lately published figure of M. Barrande, quoted above.

Localities.—Rhiwlas, near Bala, not unfrequent. We have specimens from Koenigshof, Bohemia, in the uppermost part of the Etage D. of Barrande.

J. W. SALTER.

August, 1853.

BRITISH FOSSILS.

DECADE VII. PLATE IX.

CYPHONISCUS * SOCIALIS.

[Genus CYPHONISCUS. SALTER. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Body oval, convex; head large; glabella oval, gibbous, without lobes; facial sutures marginal in front, then in an oblique and nearly straight line to the *outer* margin; free cheeks very narrow. [Eyes very forward, minute, linear.] Thorax with seven convex segments, the pleuræ with fulcrum and groove, their ends truncate, not produced; tail small, of few (1 ?) segments, its axis entire.]

DIAGNOSIS. ***C. minutus, glabellâ lævi, genis undique lineatis multo majore; sulco verticali profundo, per genas tracto, et ad angulum posticum obtusum sursum curvato; thoracis axi pleuras æquante; fulcro paullo intra dimidium posito; caudæ axi integro.***

SYNONYMS. *Cyphoniscus socialis*, SALTER (1852), Report Brit. Assoc., p. 57.

This minute crustacean literally swarms in certain reddish patches of the limestone at the Chair of Kildare, but has not yet been observed in other localities. It is evidently a member of the Olenoid group, to one genus of which, *Triarthrus*, it bears a strong resemblance in certain particulars. But it differs from it and all its congeners in the inflated form of the glabella, which is also destitute of lobes, in the small obscure eyes, and the fewness of the segments of the body. The eye has not been yet discovered, and there is so little indication of its place, that the animal might be supposed to be a blind trilobite, but that there is no instance known of a species with separable facial sutures being destitute of these organs. In the very few trilobites now admitted to be without eyes, *Agnostus*, *Ampyx*, some *Trinuclei*, &c., the facial suture is soldered. The converse however does not hold good, several genera with soldered sutures having large and well-developed eyes.

Description.—Length about one fourth of an inch. The general form is long oval or long ovate; the head, which is the broadest

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* Name from *κύφος*, a convexity, and *ὀνίσκος*, asellus. Linnæus has used 'Oniscus' for small Crustacea of somewhat similar form.

part, occupies two fifths of the entire length; it is regularly and highly convex. The glabella is encircled by a distinct furrow; it is smooth, almost gibbous, broadest in the middle, and forming a complete oval, if the neck segment be included: there are no traces of glabella lobes, but the neck furrow is strongly marked.

The cheeks are not half the width of the glabella, steeply bent downwards, and seen without the free cheeks, much narrower forwards than towards the blunt squarish posterior angle. They are confluent in front with a narrow anterior margin. Their posterior side is traversed by the continuation of a deep neck furrow. This furrow runs near the edge at first, but soon diverges, and towards its end turns abruptly upwards to the outer margin of the cheek (fig. 6, *a*). The posterior margin, thus separated, is rendered conspicuous by being, like the glabella, quite smooth, while the rest of the cheek is covered by a lineation parallel to the edge, which also continues round the front.

The facial suture (see figs. 6 and 7) is marginal for a less distance than the width of the glabella in front, then turning downwards in a gentle curve, it crosses the cheek very obliquely, and ends on the *outer* margin at the point where the neck furrow turns up to meet it. There is a slight indentation in it opposite the front end of the glabella, indicating the place of the very forward eyes, but its general course is but very little bent or sigmoid. The free cheeks are absent in all our specimens, but from the shape of the rest of the head, and analogy with similar forms of trilobites, they must have been quite linear, rather broadest in front to complete the half-elliptic form of the head, and attenuated behind. We have restored them, *b*, and indicated the probable position of the small eyes at *c*, in fig. 6.

The thorax is nearly parallel-sided, often partially coiled up, of seven* convex rings, the axis of which is prominent and as broad as the sides, in front rather broader. The sides of the axis in each segment are not sharply defined by a longitudinal furrow, but run out a little into the groove of the pleuræ, as in fig. 6, *d*. These latter are truncate and square at the ends, facetted anteriorly for rolling up, and have the pleural groove very deep, and reaching nearly to the tip, where it ends abruptly; it divides the pleura unequally,—the anterior portion is the largest. The fulcrum is placed at less than half distance from the axis, and from a little beyond this point the pleuræ are bent downwards. The convexity of the body rings, however, though considerable, is much less than half that of the head.

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* At least in the only specimen (not a full-grown one) which has still the parts in *situ*. One specimen has the appearance of possessing another ring, but it is indistinct.

Tail semicircular, the axis is entire and convex; it is marked above, like the thorax joints, by a strong articular furrow, but has no other visible segments; it occupies fully one third the width of the tail, in some specimens more,—and is surrounded by a distinct furrow. The sides are convex to their edge, the upper furrow strong and abruptly terminated; and no others are visible. The axis is smooth, the sides lineated parallel to the margin of the tail.

Variations.—We have not a sufficient number of perfect specimens to ascertain what may be the amount of variation in proportionate width, &c.; but it is evident that some have a longer and wider axis to the tail than others, and this would probably accompany a similar difference in the head and thorax; fig. 4 shows a specimen, full grown, in which the axis is considerably larger than in figs. 2 or 5.

Affinities.—We have already mentioned the close relation this has with the American genus *Triarthrus*, and the relation is perhaps the most intimate in those points in which they differ from the rest of the *Olenidæ.* Indeed were it not for *Triarthrus*, of whose affinity with *Olenus scarabæoides* there can be no doubt, it would have been very difficult to assign a systematic place to this minute and anomalous Crustacean. It has neither the parabolic glabella with its shallow parallel furrows, the long smooth eyes connected to the glabella by an ocular ridge, or the numerous body rings of many *Olenidæ*, but in the shape of the pleuræ, and in the short rounded tail, *Triarthrus* agrees with it, and they are similar too in a peculiar character quite anomalous in the group, viz., that the maxillary portion or free cheek is so reduced in size and length, that the facial suture ends on the *external* margin, and the posterior angle of cheek is turned upward to meet it, and supply its place. Of course in this case there can be no spine to the hinder angle, and thus another usual character of the group is lost. The inflation of the glabella, the minute eye, which does not seem to possess even the usual covering lobe (very distinct in *Triarthrus*), and the few body rings, 7 instead of 16,* fitted much better than *Triarthrus* for coiling up, give so distinct a character that we conceive it to form a very natural genus.

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* Hall says 13, but there are as many as 16, exclusive of 4 or 5 in the tail, in a fine specimen presented to us by Dr. Bigsby.

There is one genus, however, to which, though perhaps not identical, our fossil has a very great similarity, we mean *Tiresias*, described by Professor M'Coy, from the head only. The species *T. insculptus*, found also in the Chair of Kildare, differs from ours by its greater size, the glabella pyriform instead of half-egg-shaped, and marked on the sides by two pair of glabella furrows; the posterior angles of the head too are prolonged. But in the general form, lineation of the cheeks, &c., the two are very much alike, and when more specimens are found, it is quite possible that *Cyphoniscus* may be found to be a sub-genus only of *Tiresias*, distinguished by its lobeless glabella and blunt not produced head angles. That genus, like ours, certainly had a minute maxillary portion or free cheek, and judging from the description, the eyes appear to have been also linear and very forward.

British Localities and Geological Position.—LLANDEILO FLAGS; Limestone of the Chair of Kildare, county of Kildare, Ireland.

EXPLANATION OF PLATE IX.

Fig. 1. Small specimen, partly coiled.

Fig. 2. Young individual, with tall and seven thorax joints. In this specimen there is a portion of an eighth segment above the others, but this is probably part of the neck segment.

Fig. 2*. The same, magnified, the axis of the tail not very large.

Fig. 3. Young imperfect specimen, seven body rings.

Fig. 3*. Do., magnified.

Fig. 4. Full grown head.

Fig. 5. Full grown tail of a variety with larger axis than usual.

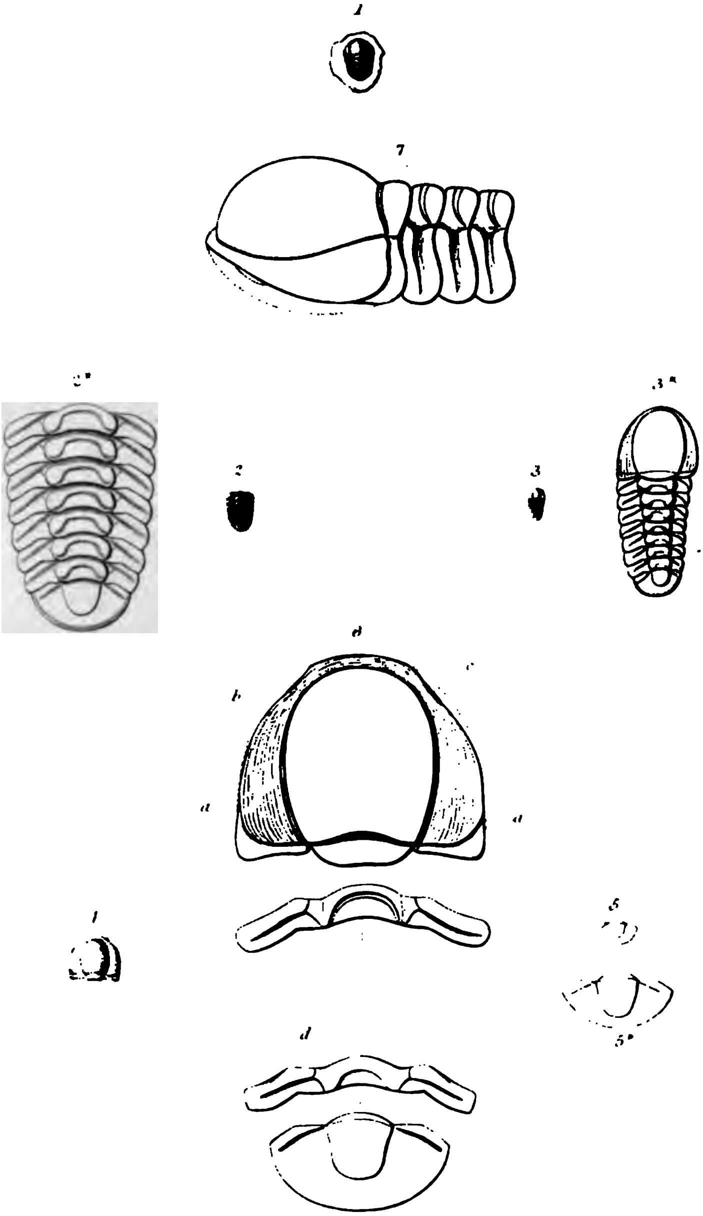
Fig. 5*. The same, magnified.

Fig. 6. Magnified figure of the head, two thorax rings, an anterior and posterior one, and tail. At *a*, the neck furrow curves upward, and terminates against the outer margin; *b*, is the restored free cheek (lost in all our specimens); *c*, the position of the eye indicated; *d*, the side part of the axis of the thorax rings, running out into the pleural groove.

Fig. 7. Lateral view of the head and three first thorax rings; the free cheek and eye are indicated as in the last figure.

J. W. SALTER.

August, 1853.



CYPHONISCUS SOCIALIS *Salter*

BRITISH FOSSILS.

DECADE VII. PLATE X. Figs. 1 to 7.

ÆGLINA MIRABILIS.

[Genus ÆGLINA. BARRANDE. (Sub-kingdom Articulata. Class Crustacea. Order Entomostraca. Tribe Trilobitæ or Palæadæ.) Body oblong, the extremities equal, rounded; head convex, glabella large, parabolic, not distinctly lobed; eyes very large, occupying the whole or nearly the whole cheek, coarsely granulated (externally?); facial suture ending on the posterior margin close to the axis, no rostral shield; thorax with 5 or 6 rings, the axis broad, the pleuræ facetted and grooved; tail large, the axis of 2 or 3 rings, abbreviated; the sides few-ribbed, or nearly smooth. *Cyclopyge*, CORDA.]

DIAGNOSIS. ***Æ. capite gibbo, glabellâ parabolicâ longâ, frontem impendente, et retrorsum lobum cervicalem fere excludente; oculis maximis, totam genam occupantibus, et sub margine glabellæ frontali connatis.***

Æglina mirabilis, FORBES, MSS.

Of all trilobites with eyes, this has the largest and most conspicuous ones, for they cover not only a large part, but the entire side of the head, leaving scarcely a margin. All the species, and there are four or five described, are furnished with these disproportionate organs of vision, but in that which forms the subject of our plate they are more largely developed than in any other, for the two eyes meet in front of the glabella, dividing that portion altogether from the front margin, and occupying therefore the whole length of the facial suture.

The genus was first sufficiently described in M. Barrande's "Notice Préliminaire sur le Système Silurien de Bohême," and is much more fully treated of in his lately published work. Previous to his visit to England, the group was supposed to be a new one; but he kindly showed us in his unpublished figures several forms of this remarkable group, none, however, in which the development of the eyes is carried to such an extravagant degree as in the British species. It is thought better, therefore, to figure so conspicuous a genus from the materials already acquired, rather than to wait for the chance of finding a perfect specimen.

M. Corda, in his voluminous but most inaccurate work, has given a drawing of this genus under the name of *Cyclopyge*,* in which the large reticulated eyes are mistaken for a granulated glabella, and the facial suture made to travel through the middle of them!

Description.—The head is three lines long by about four wide, very gibbous, almost as deep as broad. The glabella is of a parabolic form, and projects forwards beyond the eyes so as to break the oval contour of the head; behind it invades the neck segment, and almost obliterates it, leaving only a small portion on each side, which is separated from the glabella by a rather strong furrow. Lobes none, but a short oblique oval indentation on each side occurs at about the lower third of the glabella, the pair of indents being placed as far from the sides as from each other; a gentle swelling occurs beneath each impression. Some transverse arched striæ run across the base of the glabella, which otherwise appears to be smooth. Eyes very large, and occupying every part of the cheek except the lower inner angle; they are very convex, and bent round towards the under surface on the sides; they are still more convex in front, where the two eyes meet and coalesce along a median line, and are there overhung by the gibbous point of the glabella; they occupy, therefore, the entire length of the facial suture, and quite shut out the usual anterior margin. When the head is viewed on the under side, there is a short triangular space (see fig. 7, *b*) unoccupied by the lenses, which is a prolongation of the rostral portion; but except this small space, and the lower corner before mentioned, there is nothing to be seen of the anterior segment but that portion which is on the lower surface. It is not very easy to reckon the number of lenses in the eye, but they are rather large in comparison with *Asaphus* or *Illænus*, and there are not more than 1,100 or 1,200 in each eye. They were probably convex externally (as in *Phacops* and *Cheirurus*), and not covered up by a level cornea; when they have fallen out, concave pits with prominent interspaces are left upon the cast of the inner surface. The facial suture must of necessity follow the outline of the glabella in this species, and accordingly we have one specimen in which the cheeks, that is the eyes, are absent, and a thin rim only surrounds the glabella. At its posterior termination, however, this suture leaves the inner and lower angle of

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* Prodrome Monogr. Böhm. Trilob. (1847), f. 32. (*Cyclopyge megacephala*, Corda. *Ægle rediviva*, Barr.)

the eye, and cuts the small triangular neck segment in a line which turns obliquely inwards (see fig. 3, *a*). The inner corner, therefore, of this free cheek has a projecting angle inwards, and this has a prominence just at its tip. The under side of the head (fig. 7) shows a flat and rather broad rostral portion of a transversely elliptical shape, pointed at the ends; it is crossed by distant strong sharp-edged striæ, about nine or ten in number.

British Locality and Geological Position.—LLANDEILO FLAGS. Limestone of Portrane, county of Dublin (Coll. Geol. Survey).

ÆGLINA—SP. Fig. 8.

The specimens from Ireland just described show only the head, and for thorax and tail we have recourse to two specimens from Wales, which are certainly referable to the same genus, but only doubtfully so to the present species. The first (fig. 8), measuring four lines in length, shows the characteristic head and eyes of the genus joined to a thorax of six rings. The segments are narrow in proportion to their width, but this is in part due to slaty cleavage. The axis is not much arched, it is by far broadest in front, where it is two or three times the width of its abbreviated pleura; it is narrower backwards, and the pleuræ on the other hand increase in length; a strong axal furrow separates the wide axis from the sides. The pleuræ are grooved rather more deeply, owing to pressure; they are facetted anteriorly, and have the fulcrum placed at about one third from the axis, from which point they bend a little backwards and downwards. The front pleura is more strongly facetted, more bent back, and has the fulcrum nearer the axis than any of the rest, it is also somewhat wider than the others; all are blunt at the terminations.

The entire thorax in this specimen is equal in length to the head, but this latter part is so imperfect, that we cannot tell whether the glabella was prominent, and divided by a strong sulcus from the eyes; it appears not to have been so, and if this be the case, it must belong to a different species; it is however too imperfect to name.

Locality and Geological Position.—LLANDEILO FLAGS. Black slate underlying the limestones, at Stoneyford, near Haverfordwest, Pembrokeshire; (in company with Graptolites).

The other and more perfect specimen, found in Anglesea, North Wales, is so much larger than the *Æ. mirabilis*, that in the absence of the head for comparison, we are compelled to regard it as a distinct species. It may be called—

ÆGLINA MAJOR. Fig. 9.

DIAGNOSIS. *Æ. uncialis et ultra, lævigata; thorace regulariter convexo, sulcis axalibus haud profundis; axi lato, antice ter, postea bis pleuras superante; pleuris truncatis obtusis, paullum deflexis, fulcro ad tertiam posito; caudâ magnâ, semicirculari, regulariter convexâ nec marginatâ; axi latè conico, ad apicem obscuro, annulis binis; lateribus trisulcosis, sulco antico profundo, reliquis obscuris.*

This specimen has lost the head and first thorax ring.* The remaining portion measures three quarters of an inch in length, by seven lines in breadth, and of this the tail is four and a half lines long, and equal to the thorax. The general convexity is considerable, and equal over all parts; the axis is separated from the pleuræ by a sharp but not deep sulcus, and is broader in front than behind, in the proportion of four to three. The anterior ring being broken off, however, we can only compare the axal portion with the second pleura, and it appears to be rather less than three times its width. The last pleura is half as wide as the axis of that segment. The pleuræ are blunt at their ends, facetted anteriorly, and have the fulcrum placed at one third from the axis, from which point they bend a little backward and downwards with the general convexity. The pleural groove is less deep than in the former specimen, probably because this one has not suffered longitudinal pressure.

The tail is a semicircle, equally and regularly convex, with no raised border. The axis is but very slightly marked, it is broad above, then rapidly narrowing, and soon lost before reaching one third down the tail. One distinct ring is marked off on its upper portion. The sides have the usual facetted external angle, and the equally constant strong upper furrow (which might be called the articulating furrow, being always present in some form or other); below this there is a second much fainter one, at the distance of a thorax segment's breadth, parallel to the upper furrow; and a third closely approximating to the second at its origin, and then diverging downwards. These furrows, except the uppermost one, are faint. The tail is marked in some parts with a tranverse lineation, otherwise it is smooth.

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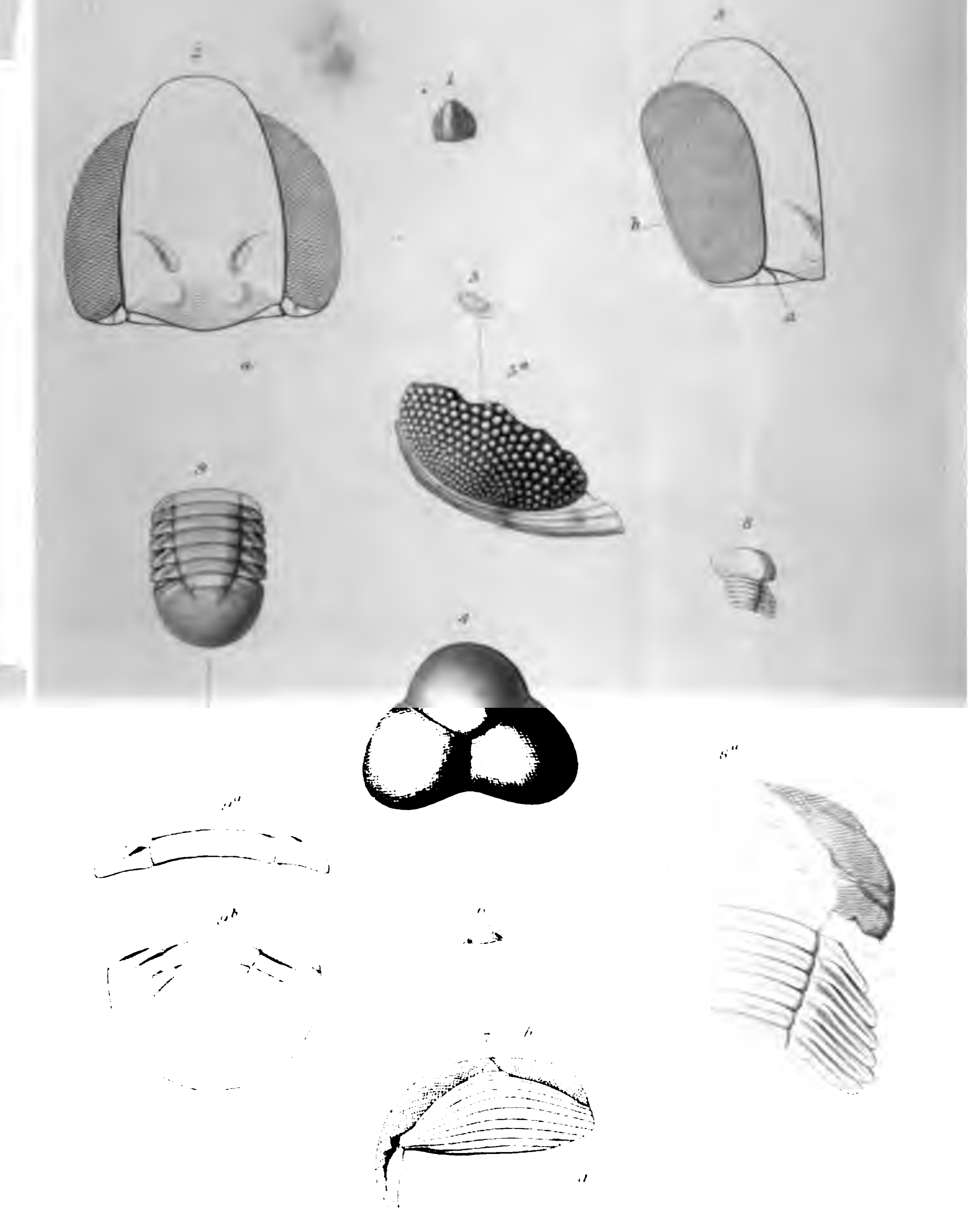
* Unless this may be a 5-ringed species, which is quite possible.

gical Survey of the United Kingdom.

ÆGLINA
(Silurian)



Figs. 1-7. ÆGLINA MIRABILIS Forbes

8 sp? (Æ. MIRABILIS?)

9 — — MAJOR Salter

Locality and Geological Position.—LLANDEILO FLAGS, (lower portion ?) Glan-y-gors, three miles south-east of Llanerchymedd, Anglesea, in nodules among black shale, containing also Graptolites and Lingula.

Affinities.—*Æ. rediviva*, the first described species of this genus, differs from *Æ. mirabilis* by a much broader glabella, and smaller eyes which do not meet in the front; nor is this latter remarkable character known in the other Bohemian species. In other respects, in the tail and six thoracic rings of the same general form, *Æ. rediviva* is very like our species, the axis of the thorax being very wide in front, while the corresponding pleuræ are small; it has also a similar pair of glabella furrows. *Æ. pachycephala* has large but angular eyes, and only five thoracic segments; the other species, *Æ. speciosa*, Corda, does not require comparison.

The affinity of the genus itself is pretty clearly with the Asaphoid group, with which, especially with such forms as Nileus and Illænus it has many points in common. The form of the thorax rings and the smooth almost lobeless glabella are indications of this; and on the under side of the head, the tranverse striated rostral portion strikingly recalls the analogous part of Illænus (see Decade II., pl. 2. fig. 4), although the rostral shield is not separate. The grooved pleuræ, facetted for rolling up, and truncate at their ends, are more like those of Asaphus; and the tail, with its abbreviated axis and few obscure lateral ribs, reminds us of Ogygia Portlockii. Its affinities seem, therefore, more evident with the Asaphoid group than with Bronteus, to which in other respects the genus does not seem very closely allied. But in the extraordinary development of the eyes at the expense of the cheeks, it has no analogue that we know of, except the Remopleurides, as figured in our plate 8 of this Decade. With that group it appears to have no real affinity.

The genus is only yet known in the Lower Silurian rocks.

EXPLANATION OF PLATE X.

Fig. 1. Perfect head of *Æ. mirabilis*. Portrane; natural size.

Fig. 2. The same, magnified; at *a*, the small prominences beneath the glabella furrows are seen.

Fig. 3. The same, side view; at *a*, the posterior termination of the facial suture; *b*, the scarcely perceptible outer margin of the cheek.

Fig. 4. Front view, showing the large reticulated eyes meeting in front.

Fig. 5. A portion of the lower end of the eye, and inner angle of the free cheek ; same locality.

Fig. 5 *a.* The same, magnified, and showing the convex lenses closely set together.

Fig. 6. Under surface of the head ; same locality.

Fig. 7. The same, magnified ; at *a*, the broad striated rostral shield or clypeus ; *b*, its forward prolongation between the eyes.

Fig. 8. *Æ. sp.* (*Æ. mirabilis?*) from Stoneyford, Haverfordwest ; much distorted and pressed into a shorter form by cleavage ; 6 thorax segments.

Fig. 8 *a.* The same, magnified.

Fig. 9. *Æglina major.* Llanerchymedd, Anglesea ; natural size.

Fig. 9 *a.* Shows the penultimate thorax ring, magnified ; the axis but little more than twice the width of the pleura ; in the anterior ones the axis is wider ; *b*, the tail, similarly magnified.

J. W. Salter.

August, 1853.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE VIII.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

LONDON:
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LONGMAN, BROWN, GREEN, AND LONGMANS.
1855.

PREFACE.

THE dates of the accompanying descriptions by Sir Philip de Malpas Grey Egerton, Bart., have been retained to show when they were respectively completed; but the Decade itself was not published in consequence of a desire of the late Professor Edward Forbes to issue Decade V. at the same time. The appointment of Professor Forbes to the Chair of Natural History in Edinburgh interfered with this arrangement, and a further delay was experienced at his death from the inability to discover the MSS. amongst his papers. The original MS. is now published after having been passed through the press by its author.

H. T. DE LA BECHE.

2nd April 1855.

ERRATA IN DECADE VI.

PLATE VI.—*For* "Histionotus" *read* "Ophiopsis."

ARTICLE VI., page 1, 21st line from the bottom.—*For* "dorsal" *read* "caudal."

ARTICLE VII., page 2, line 10 from the bottom.—*Omit* "which I have proposed to remove to the new genus Histionotus."

BRITISH FOSSILS.

DECADE VIII. PLATE I.

ASTERACANTHUS GRANULOSUS.

[Genus ASTERACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Placoidei. Family Cestraciontidæ.) Dorsal spine large, tuberculate, with a double row of processes on the posterior margin; base smooth.]

Asteracanthus granulosus, SP. NOV.

Description.—The characters assigned by Professor Agassiz to the genus *Asteracanthus*, are striking, constant, and unmistakeable. The leading features of these Ichthyodorulites are the tubercular surface of the dorsal ray, and the stellate ornament of the tubercles. In the typical species, *Asteracanthus ornatissimus*, found in the Kimmeridge clay, these characteristics attain their maximum development—in the species under consideration, from the Tilgate beds, they are reduced to the minimum. The specimen represented (fig. 1. of the Plate) is the only one approaching a perfect state I have met with. It probably belonged to a young individual. The other figure is taken from a fragment of a much larger ray, in the British Museum, belonging to the same species. The length of the former is nearly 1 foot; when perfect it probably measured an inch more. The base at the front of the ray is only 4 inches in length, but the cavity at the back extends upwards of 8 inches. It is scarcely possible that the whole of this can have been imbedded in the muscles; it is more likely that it supported a large adipose or membranous fin, attached to the hinder surface, and embracing the cavity, but leaving the rough outer part of the bone exposed for offensive or defensive operations. The whole texture of the bone is remarkably coarse and fibrous. It is traversed by inosculating canals, interspersed with pores, arranged in longitudinal series, and showing a reticulated pattern, when examined with a lens. The root and the hinder surface as high as the termination of the cavity are smooth, and free from ornament. The remainder of the ray is covered by numerous smooth tubercles, isolated, but arranged in longitudinal series, parallel to the long axis of the bone. They are smaller in this species than in any other yet discovered, resembling coarse grains of sand; they, nevertheless, have the radiating lines on the apex, so constant in all the *Asteracanthi*. The specimen in the British Museum is a fragment of the lower portion of the ray. It measures 7 inches in length. A second fragment, also in the British Museum, measures 5 inches. In these specimens, as is usual in the rays of full grown individuals of the genus, the asteroids are more distant than in the younger ones. They are small in size, and patelliform in figure, the apex being eccentric, and approaching the upper periphery. Their bases are smooth, the stellate rays becoming obsolete before descending so far. The general outline of the ray is very slightly recurved. The anterior margin is rounded, and without carina. The sides expand considerably, so that the back of the fin is broad, as seen in the transverse section (fig. 4). There is no evidence to lead to any conjecture as to the form of tooth belonging to this species; the only Placoid teeth hitherto discovered in the Tilgate beds being referable to the genera *Hybodus* and *Acrodus*.

Locality.—The original of figure 1. of the Plate is from the ferruginous grit beds of Tilgate forest, and was presented to me by the late Mr. Dixon. The specimen in the British Museum (figs. 2, 3, 4,) is derived, apparently, from the same beds, and formed part of the Mantellian collection.

EXPLANATION OF PLATE.

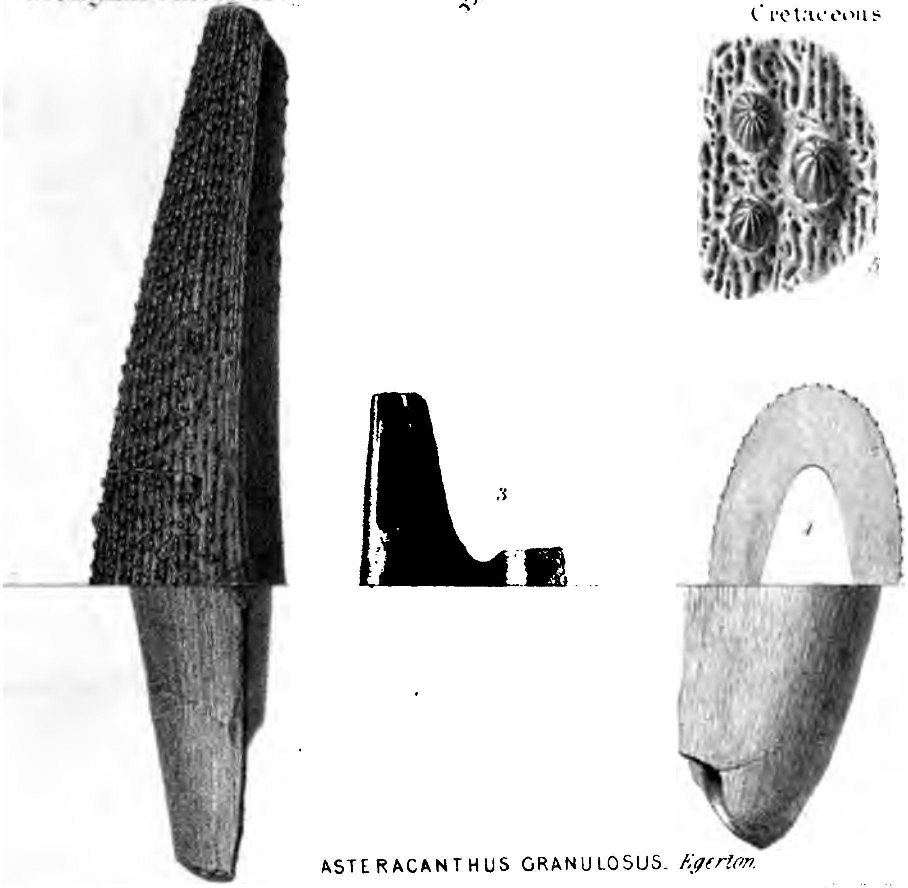
Fig. 1. **Asteracanthus granulosus, size of nature.**
Fig. 2. **Asteracanthus granulosus, size of nature.**
Fig. 3. **Interior of ditto.**
Fig. 4. **Transverse section of ditto.**
Fig. 5. **Portion of No. 1 magnified.**

Geological Survey of the United Kingdom.

DECADE 8. PL. I

ASTERACANTHUS.

Cretaceous



ASTERACANTHUS GRANULOSUS. Egerton.

BRITISH FOSSILS.

DECADE VIII. PLATE II.

ASTERACANTHUS VERRUCOSUS.

[Genus ASTERACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Placoidei. Family Cestraciontidæ.) **Dorsal spine large, tuberculate, with a double row of processes on the posterior margin; base smooth.**]

Asteracanthus verrucosus, SP. NOV.

Description.—The genus *Asteracanthus*, although for the most part an oolitic form, extends nevertheless upwards into the Tilgate beds, as shown in the preceding article. The typical species, *Asteracanthus ornatissimus*, is a fossil of the Kimmeridge clay. The remarkable character of this Ichthyodorulite attracted the notice of collectors at a very early period. On the 29th of March 1753, a paper, by Mr. Henry Baker, was read before the Royal Society entitled, "An Account of some uncommon Fossil Bodies." This paper is printed in the Philosophical Transactions of the Royal Society for that year. The specimens described and figured are a spine of a *Hybodus*, from Aust Passage, and several examples of the Shotover-hill Asteracanth. The detailed descriptions, as also the representations, are tolerably accurate, but the conclusion drawn is, that "the general appearance of these fossil bodies gives reason to conjecture, that they are bones belonging to the head or snout of some animal of the fish kind, or perhaps of some lizard, alligator, or crocodile." The credit of determining the true nature of these curious fossils is due to Doctor Buckland and Sir Henry De la Beche, who some years ago prepared a joint paper on the subject, which unfortunately was never published. The facts and materials collected by these authors were liberally conceded to Professor Agassiz, when engaged on his valuable publication on Fossil Ichthyology, and he stamps with his authority the correctness of their opinions. The very elegant fossil which forms the subject of this article belongs undoubtedly to the genus *Asteracanthus*, but differs specifically from all those hitherto described. The length of the specimen is 10½ inches, but the apex is wanting to the extent of perhaps ½ an inch. Taking the length as 11 inches, the base of the front of the spine occupies barely 3, but the cavity on the posterior surface extends for 7 inches. It is, therefore, probable that the membranous fin concealed more of the spine on the back than on the front, a feature found in some of the recent Placoids, with spine-bearing fins. The line of junction between the base and the ornamental portion is less oblique than ordinary, which proves a more erect position of the fin in this than in the other species of the genus. The external surface is closely beset with tubercles, smaller in size and far more numerous than in *Asteracanthus ornatissimus*. They are arranged in very regular longitudinal series, parallel with the front edge of the bone. They become less numerous as they recede from the front, and cease altogether on the posterior margins. The tubercles are oval, the larger diameter coinciding with the direction of the rows; on the distal portion of the spine they become smaller and more elongated. They are all ornamented with deep grooves, radiating (in some instances spirally) from the apex, the stellate surface being of harder material than the base of the tubercle. The substance of the spine bearing these ornamental projections is very coarse and fibrous. The base is also composed of similar material. It has been already stated that the cavity of the spine extends for nearly two thirds of the back aspect; the surface beyond this point, which marks the determination of the cutaneous investment, was armed with a double row of falcate processes, in alternating order, a feature common to other species of the genus. Professor Agassiz conjectures that this form of Ichthyodorulite probably belonged to the genus *Strophodus*, in consequence of the frequent occurrence of teeth of this genus in association with *Asteracanthus* spines, in the Kimmeridge clay of Shotover, and the oolite of Stonesfield. I am not, however, aware that teeth of *Strophodus* have, as yet, been discovered in the Swanage beds.

Locality.—This form of spine is not uncommon in the Purbeck strata of Swanage and the neighbourhood. The specimen I have selected for the figure and description, belongs to the Dorchester Museum, and was, I believe, obtained with many other fine Purbeck fossils from Mr. Wilcox, of Swanage.

Note.—Mr Beckles, of St. Leonards-on-Sea, possesses an Ichthyodorulite, found in the Paludina beds, near Hastings, which varies in some respects from the species described in this article, but it has suffered so much from attrition, that the evidence of specific difference is insufficient.

EXPLANATION OF PLATE.

Fig. 1. Asteracanthus verrucosus, size of nature.
Fig. 2. Tubercle, magnified.

P. DE M. GREY EGERTON.

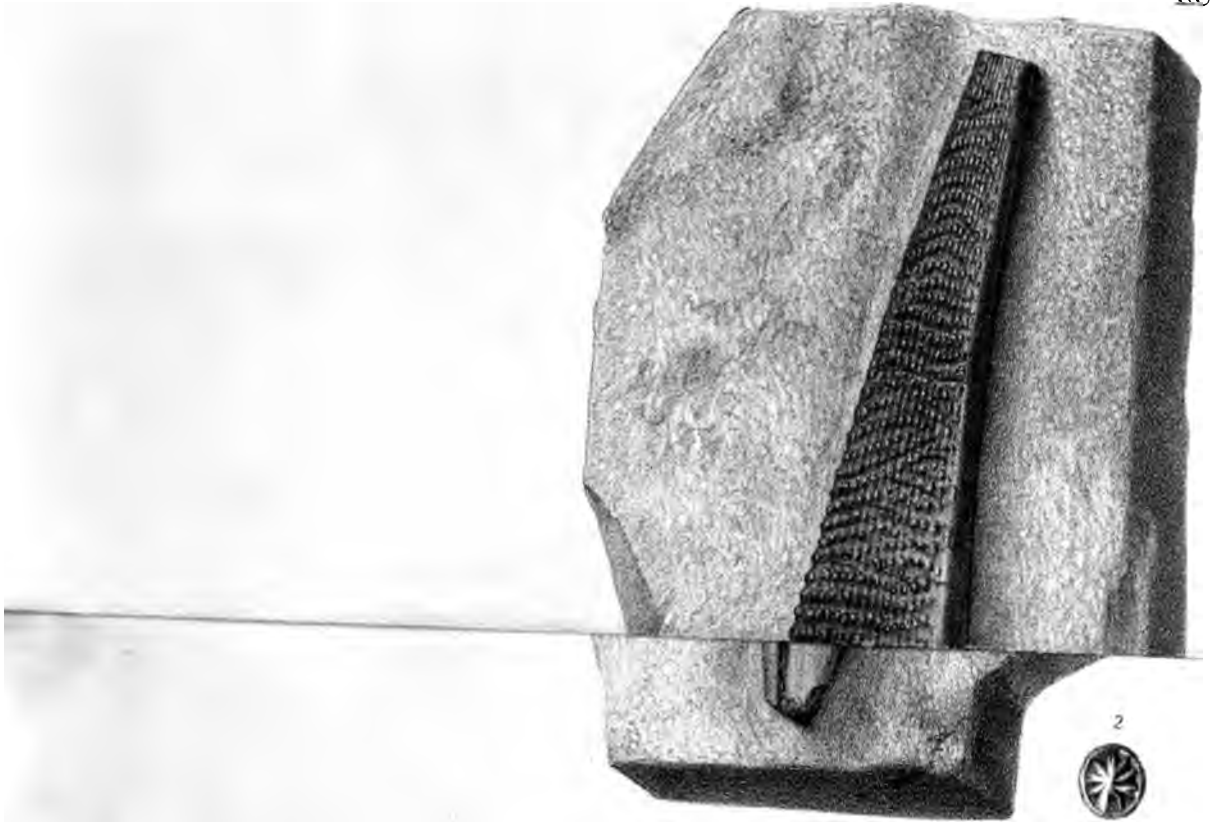
May 1853.

Geological Survey of the United Kingdom.

DECADE X. PL. 2

ASTERACANTHUS,

Oolite



BRITISH FOSSILS.

DECADE VIII. PLATE III.

ASTERACANTHUS SEMIVERRUCOSUS.

[Genus ASTERACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces Order Placoidei. Family Cestraciontidæ.) Dorsal spine large, tuberculate, with a double row of processes on the posterior margin; base smooth.]

Asteracanthus semiverrucosus, SP. NOV.

Description.—This Ichthyodorulite is very distinct from the specimen described in the preceding article, so much so, that I have no hesitation in considering it a new species. Experience has taught us that in those Placoid fishes which had more than on spine, the second dorsal defence differed more or less in form and other peculiarities from the principal one, and thus specimens considered originally as distinct are now recognized as belonging to one and the same species. For instance, *Hybodus curtus*, and *H. reticulatus*, formerly described in the "Poissons Fossiles" as two species, are now shown to have been the first and second dorsal defences of the same fish, and are consequently united under the latter denomination. But there are limits to these variations; and there is, moreover, a general similarity of character, which the experienced eye cannot fail to detect, although to a certain extent disguised by the deviations from a recognized type. In the subject before us there are the strongest evidences of specific difference from *Asteracanthus verrucosus*, as will be seen in the sequel. The specimen is deficient at the point and at the base. The portion remaining measures 7¼ inches. If entire, the length would probably have been about 9 inches. The greatest breadth is $1\frac{1}{10}$ inch, from which point the spine contracts very gradually. It is more falcate than any other species of the genus. The anterior face is characterised by a strong carina, which is broken up into tubercles, near the base. The sides of the spine are covered for one half of the entire length with large coarse tubercles, irregularly arranged, and varying both n shape and size. The largest are near the front, these are the most irregular in shape, some being circular, some elongated longitudinally and others transversely. They are coated with a hard enamelloid substance, sculptured with a few radiating sulci. The tubrecles decrease in size on approaching the posterior edge, and become obsolete before they reach it. The hinder rows are more regularly arranged than the anterior ones, forming lines parallel to the back of the spine. On the upper half the tubercles retain the same characters, but are fewer in number and more scattered. They are also intermixed with continuous ridges, similar to those ornamenting the rays of the *Hybodi*. Some of them are undulating on the edge, as if they resulted from the confluence of a row of tubercles. The angle formed by the junction of the lateral and posterior planes is slightly obtuse on the distal portion, but becomes nearly a right angle at the base. The posterior plane is furnished with a few coarse processes near the point. The root of the spine, and indeed the whole of the surface unoccupied by the superficial ornament, is composed of coarse fibrous bone. The line of demarcation between the external and inserted portions of the spine is very oblique, more so than in any other species. These characters, well shown by Mr. Dinkel, in the lithograph representation, serve to distinguish this from all the members of this genus hitherto described.

Affinities.—The irregular arrangement of the tubercles on the sides of this spine is found in *Asteracanthus Preussi* (Dunker),* but the latter differs in every other respect. Of the rays described by Professor Agassiz, *Asteracanthus acutus* is certainly the nearest ally of this species. It is distinguished from it by a more tapering form, the smaller size and more regular disposition of the tubercles, and by the greater number of defensive processes on the posterior surface. The *Asteracanthus semisulcatus* of Agassiz, has some resemblance to it in the admixture of ribs with the tubercles, but in other respects it is very distinct. In describing the latter species, Agassiz surmises it to be identical with the *Ichthyodorulites Purbecensis* of Buckland and De la Beche, but as it is a fossil very characteristic of the Stonesfield oolite, I am inclined to think the Purbeck specimen seen by the latter authors may with more probability be assigned to the species described in this article. In addition to the three new British species of *Asteracanthus* described in this Decade, I have a specimen of distinct character from the Caen limestone. It is a short, thick spine, densely covered with coarse

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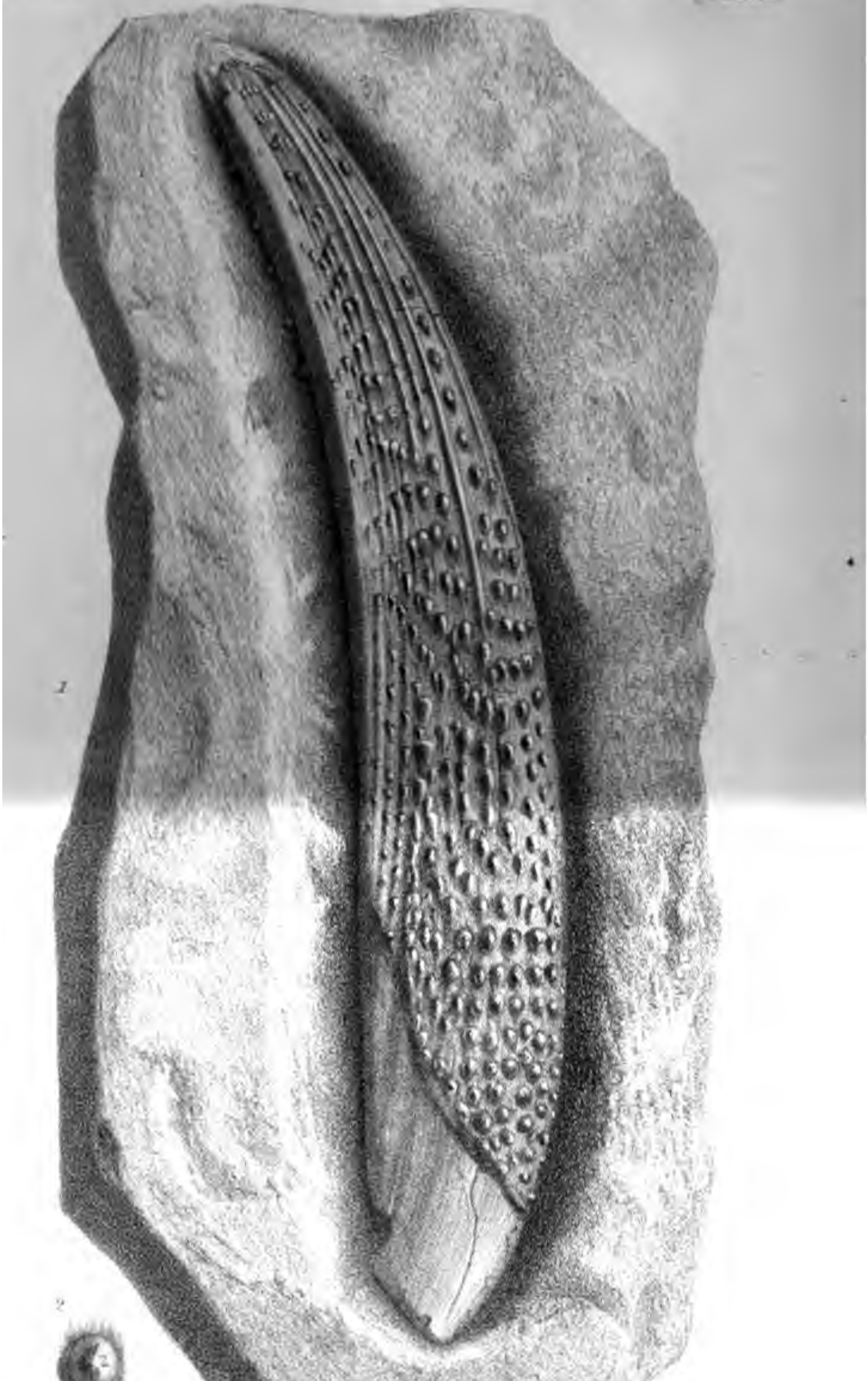
* Palæontographica, vol. i. p. 188.

gical Survey of the United Kingdom.

ASTERACANTHUS
(Oolitic)



ASTERACANTHUS SEMIVERRUCOSUS — *Egerton* stellate tubercles, each of which is supported on a circular, smooth base or pedestal. I have named it *Asteracanthus papillosus.*

Locality.—The only specimen I have seen of this species is one from Swanage, presented to the Dorchester Museum by Mr. Williams, and liberally placed at my disposal, for description, by that institution.

EXPLANATION OF PLATE.

Fig. 1. Asteracanthus semiverrucosus, size of nature.
Fig. 2. Tubercle, magnified.

P. DE M. GREY EGERTON.

May 1853.

BRITISH FOSSILS.

DECADE VIII. PLATE IV

PHOLIDOPHORUS GRANULATUS.

[Genus PHOLIDOPHÓRUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2d Group. Body elongated, more or less fusiform.) Dorsal fin small, opposite the ventrals; caudal fin forked; the lobes equal; the base of the upper lobe invested with scales: teeth villiform.][*]

Pholidophorus granulatus, SP. NOV.

Description.—The genus *Pholidophorus* makes its first appearance during the deposition of the lias, and contributes some of the most characteristic forms of the fauna of that period. No less than fifteen species are named and described from that formation alone. The succeeding members of the oolitic period in Great Britain are singularly deficient in species of this genus as compared with the continental deposits of corresponding age ; for of the nineteen oolitic species enumerated by Professor Agassiz in the "Poissons Fossiles," only one, *Pholidophorus Flesheri*, occurs in England. The more recent deposits have only furnished one species, the *Pholidophorus ornatus* of the Purbeck strata of Swanage. The single specimen examined by Agassiz, and consequently the type of the species, is a mere fragment, formerly belonging to the late Doctor Mantell, but now in the collection of the British Museum. On comparing this, the original, with the representation given in the "Poissons Fossiles," an error becomes manifest in the position of the dorsal fin. The impressions of some broken scales in the neighbourhood of the tail have been mistaken for the rays of the dorsal, and this character has been embodied in the text as distinctive of the species, whereas the true rays of the dorsal fin are traceable in the position which usually obtains in the *Pholidophori*, viz., the middle of the back. The peculiar character of the scales is, however, sufficient to distinguish the species from all others. Very fine specimens have recently been found which prove this character to be constant and uniform; so much so, that a single scale could at once be recognized without fear of error. The subject of this article constitutes a second species, also from Swanage, and more nearly allied to *Pholidophorus ornatus* than to any other species. The distinctive feature most easily appreciable is the greater depth of the body as compared with the length; there are also differences in the form and ornamentation of the scales, which will be described in the sequel. The specimen selected for representation measures 6½ inches from the snout to the commencement of the tail. The depth of the body from the anterior limb of the dorsal fin to the insertion of the ventral fin, is 2¾ inches; and from the nape to the insertion of the pectoral fin, 2 inches. These relative dimensions in a specimen of *Pholidophorus ornatus*, 6 inches in length, are only 1½ inch for the former, and 1¼ inch for the latter, a difference too remarkable to be attributed either to sexual peculiarities or to accidental circumstances. The head measures 1½ inch in length, and 1¾ in depth, while in the allied species these dimensions are reversed, the length being greater than the depth. The bones of the head are prettily ornamented with groups of granules arranged in a variety of patterns. They are most numerous on the frontals and pre-frontals. This granular character occurs also on the branchiostegous rays, the opercular flap, and the scales extending from the occiput to the dorsal fin. The operculum is of moderate size, but the sub-operculum is enormously developed in the vertical direction. The granular character is less prominent on these bones than on the other parts of the head. The dorsal fin is placed nearer the head than is the case in *Pholidophorus ornatus*. It is composed of about a dozen rays, of which the first four are short and single, the remaining ones broad with frequent transvere articulations, and bifurcate extremities. The pectoral fins are of moderate size, and contain about 18 rays, all slender except the first, which is thick and strong. The distance between these and the ventral fins is less than in *Pholidophorus ornatus*. The latter organs contain each from 10 to 12 rays. The exterior one has an ornamental border of oblique osselets, the succeeding ones are stronger than those of the pectoral fin, and have few transverse articulations, these being restricted to the distal, bifurcate, extremities. The anal fin is equidistant from the insertion of the ventrals and the commencement of the tail. Only a trace of it remains. The caudal fin is also deficient. The lateral line is nearly horizontal. The scales

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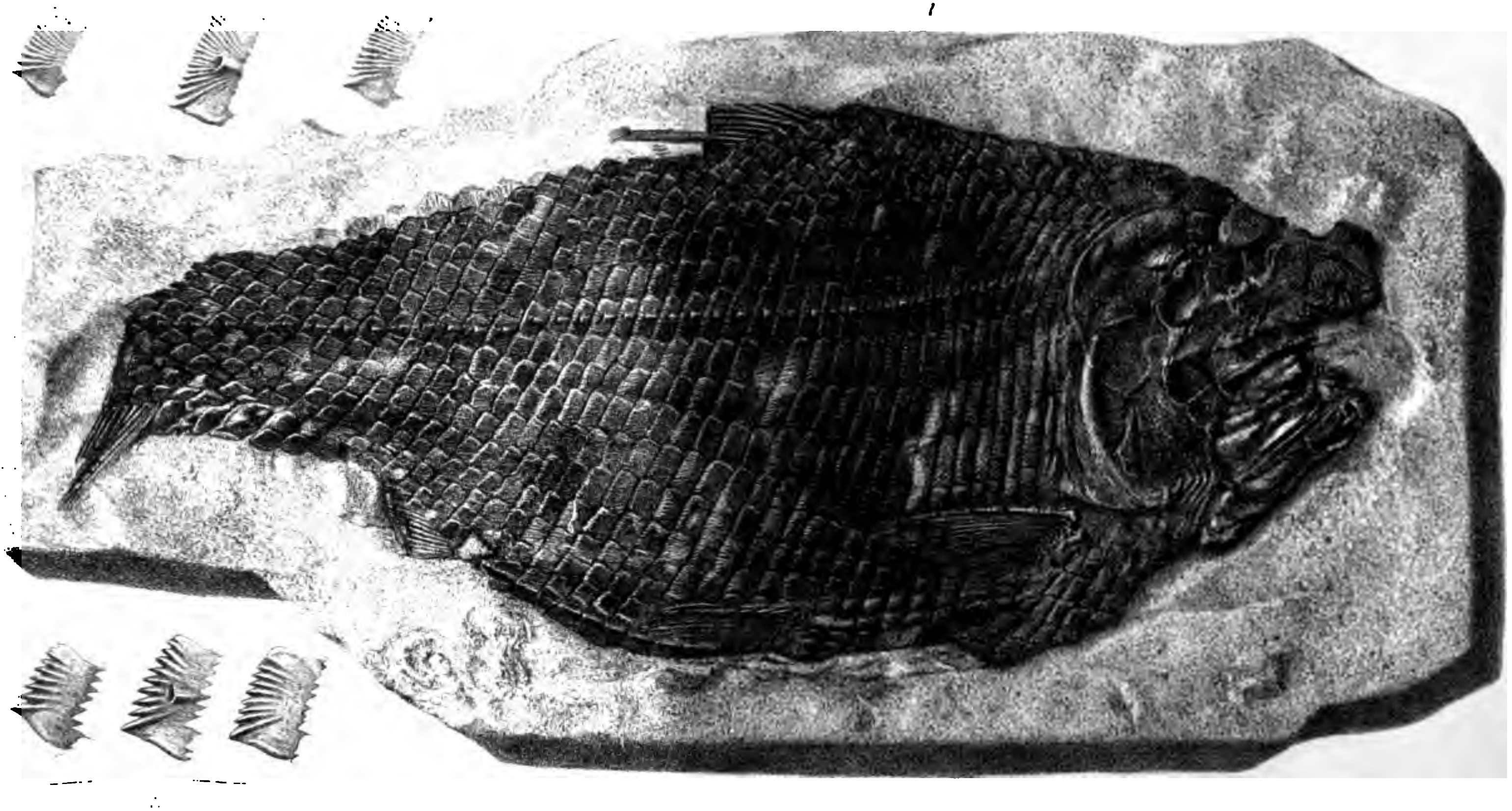
[*] Poiss. Foss. vol. 2, p. 9.

[illegible]

DECADE 6. PL. 4.

PHOLIDOPHORUS.

(Oolitic.)



PHOLIDOPHORUS GRANULATUS — *Egerton.*

(Natural size.)

[illegible]

it traverses are large and fan-shaped. The surface of these scales is covered with distinct striations radiating symmetrically from the central line, and about 24 in number, 12 above the lateral line and 12 below it. In the scales above and below this principal series, the striæ are more divergent and oblique on the lower part of the scales than on the upper. On the back, and occasionally in other parts, the striæ are intermixed with fine granulations. The posterior edges of the scales are serrated. The scales in *Pholidophorus ornatus* have the striations less numerous, coarser, and less divergent; and the posterior edges are more deeply notched. The scales on the back and belly in both species are considerably smaller than those on the flanks.

Locality.—This species was procured at the Swanage quarries by Mr. Wilcox, and transferred with his collection to the Dorchester Museum.

EXPLANATION OF PLATE.

Fig. 1. Pholidophorus granulatus, size of nature.
Fig. 2. Scales magnified.
Fig. 3. Scales of Pholidophorus ornatus, magnified.

P. DE M. GREY EGERTON.

July 1853.

BRITISH FOSSILS.

DECADE VIII. PLATE V.

ISTIONOTUS. GEN. NOV.

[Genus HISTIONOTU (ἱστιον, a sail, and νωτος, the back). EGERTON. Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2d Group Body elongated, more or less fusiform.) Dorsal fin commencing behind the nape and extending to the tail; teeth elongated; scales serrated, articulated as in Pholidophorus.]

Histionotus angularis. SP. NOV.

Description.—The subject of this article presents a more remarkable combination of characters than any fossil fish with which I am acquainted. It has the head and tail of a *Lepidotus*, the dorsal fin of an *Ophiopsis*, the scales characteristic of the genus *Pholidophorus* and the form of a *Semionotus*. At the same time it differs so essentially from each of these genera, that it can be assigned to none of them. The generic title I have adopted records its most emblematic feature, the dorsal fin. The specimen figured in the accompanying plate, (the only one of which I am at present cognizant, with the exception of an imperfect one in the Museum of Practical Geology,) measures 6 inches from the nose to the commencement of the caudal fin, the head occupying about one third of the entire length. The greatest depth, 2¼ inches, occurs at the point of commencement of the dorsal fin. The outline of the head very much resembles that of *Lepidotus minor* in the rapid declination of the frontal bones and the prognathic character of the jaws. The interior of the mouth is not visible; it is impossible, therefore, to determine whether it was furnished with supplementary teeth, as in *Lepidotus* and *Semionotus*, or with a single row, as in *Pholidophorus*. The principal series is well displayed; the teeth composing it are very uniform in size and shape; they are straight elongated cones with blunt apices, and quite smooth on the surface; nearly resembling the outer teeth in some of the slender-toothed *Lepidoti*; the pre-operculum is unusually strong and very rugged on the surface. The other opercular bones are high and narrow; they are covered superficially with flattened imbricated scales of ganoine. The coracoid bone is broad and flattened out posteriorly. The superficial ornament is uniform with that on the opercular bones. The rays composing the pectoral fins are long, and the transverse articulations near their extremities are very numerous; they are about 12 in number No fulcral rays appear to have been present in these fins. The ventral fins are situated rather behind the centre of the body. They are of moderate size, and have several strong elongated scales on their anterior margins. The impression alone of the anal fin is preserved. This shows it to have been of considerable size, and to have extended very far back, almost to the commencement of the caudal fin. The latter fin is also, for the most part, deficient in the specimen, although enough is seen to prove its resemblance to this organ in *Lepidotus*. The most remarkable feature in this fish is the dorsal fin. It originates about half an inch behind the occiput, and extends from thence without interruption to the commencement of the lobe of the tail. The outline of the back is also very peculiar in this fish. It rises rather abruptly from the head to the dorsal fin, it then declines gradually for about 2 inches, and thence slopes suddenly to the tail. In lieu therefore of the graceful sweeping form which generally prevails in this family, we have a somewhat angular outline of back, which, together with the prominent snout, has suggested the specific name. The dorsal fin is fortified by a set of fulcral scales and spines on its anterior margin, but these are by no means so strongly developed as in the species of *Lepidotus* most nearly allied to this genus. The fin rays are thick, they bifurcate at a short distance from their base, and are thence traversed by numerous approximate transverse divisions. Before the point of bifurcation these articulations are few. It is impossible to count the number of the rays, as the fin is by no means perfect, they cannot, however be computed at fewer than 40. The scales are very uniform in size and shape in all parts of the body, except in the vicinity of the tail. The exposed surface is rhomboidal, the vertical axis being the longest. The angles vary but slightly from right angles. The upper posterior ones being slightly acute, the lines of union between the scales in the dorso-ventral series are oblique to the longitudinal axis of the body; the more so from the direction of the series themselves being at a considerable angle downwards and backwards. There are from twelve to fourteen scales in each series. The lateral line is nearly straight; it occupies the sixth row of scales in descending

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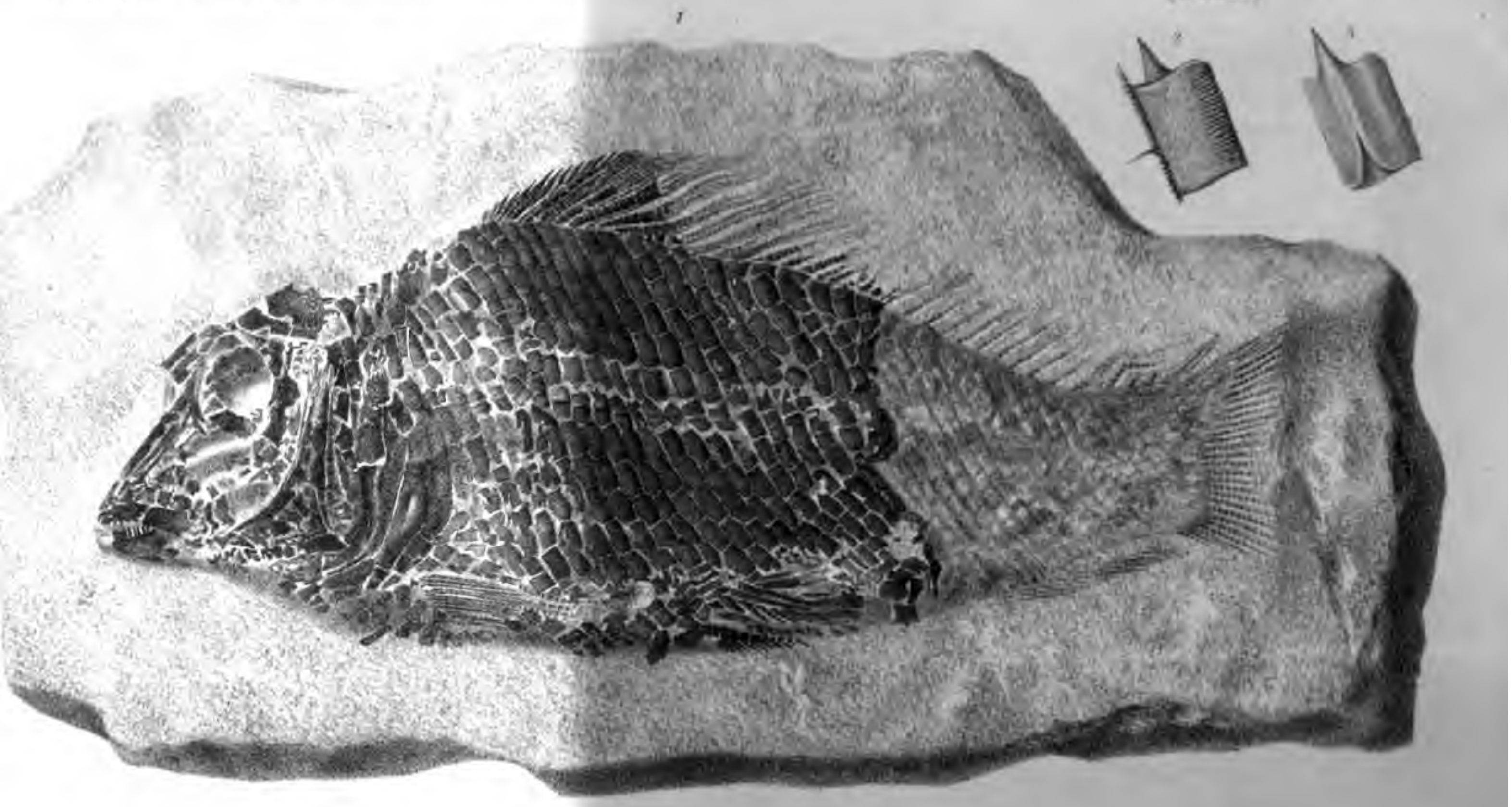
(Oolite.)



HISTIONOTUS ANGULARIS. _Egerton._

[illegible] lith.

E. Forbes direx^{t}.

Day & Son, Lith^{rs} to The Queen.

order from the back. The surface of all the scales is smooth on the anterior portions. The posterior margins are finely serrated, and the surface of the scale in the vicinity of the serrations is finely striated; the striæ agree in number with the serrations, being due to the persistance of the marginal serrations of earlier periods of growth. The scales are united by long processes on the undersurfaces, very similar to the corresponding parts of the scales of *Pholidophorus*, and differing entirely from those of *Lepidotus* or *Ophiopsis*.

Affinities.—The affinities of the genus *Histionotus* have been considered at the commencement of this article. I would only add that, on the whole, it seems to be more nearly allied to *Pholidophorus* than to any other genus. It may, perhaps, hereafter be thought advisable to remove to this genus some of the fishes with long dorsal fins now grouped with the *Pholidophori*, rather than to the genus *Ophiopsis*, as suggested in the description of *Ophiopsis breviceps* in the Sixth Decade.

Locality.—The specimen described above, and figured in the accompanying plate, was procured by me in the course of the present year from one of the quarries of Purbeck stone at Swanage.

EXPLANATION OF PLATE.

Fig. 1. Histionotus angularis, size of nature.
Fig. 2. Scales, magnified.
Fig. 3. Under surface of scale, magnified.

P. DE M. GREY EGERTON.

May 1853.

BRITISH FOSSILS.

DECADE VIII. PLATE VI.

ASPIDORHYNCHUS FISHERI.

[Genus ASPIDORHYNCHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Body much elongated; upper jaw produced in the form of a beak; pectoral and ventral fins rounded; dorsal fin far back and opposite the middle part of the anal fin; tail forked; scales higher than wide, especially in the middle part of the body; teeth extending in the upper jaw beyond the point of the lower jaw.]*

Aspidorhynchus Fisheri. SP. NOV.

Description.—Three species only of this genus are figured and described by Professor Agassiz in the "Poissons Fossiles." In addition to these, six others are named and briefly noticed. The characters of all these are well known to me, with the exception of *Aspidorhynchus Walchneri,* a fossil of the lias of the Oberland Badois; of which I have never seen a fragment. As no information is given with respect to this fish, and as it is not likely that it can be identical with a Purbeck species, it will be omitted in considering the subject before us. Of the eight remaining species, five are from the oolites of Solenhofen and Kelheim; one from the lias of Whitby; one from the Oxford clay of Christian Malford; and one from Barra do Jardim in Brazil, from a stratum probably about the age of the Green Sand. The subject of this article, a fish of the Purbeck beds, differs in many respects from all the species alluded to by Agassiz, and possesses individual features so clear and distinctive, that it would be superfluous to enter at length into a description of the agreements and discrepancies existing between it and the other members of the genus. A simple enumeration of the characters of the species will suffice to establish it without risk of confusion. In form and proportions, it holds an intermediate position between *Aspidorhynchus acutirostris* and *Aspidorhynchus mandibularis,* being more slender than the former, and less so than the latter. In general appearance it is not unlike the common *Belone* of our British seas. The specimen selected for description has been kindly lent for that purpose by the authorities of the Dorchester Museum. It measures 13 inches from the snout to the base of the caudal fin, and $1\frac{3}{4}$ inch in depth at its greatest diameter. The head measures $3\frac{3}{16}$ inches in length; nearly 1 inch of this measurement being due to the prolongation of the rostrum beyond the symphisis of the lower jaw. This portion of the snout is characterized by deep longitudinal striæ, while the base is perfectly smooth. The surface of the cranial bones, but more especially of the prefrontals, is studded with small granules interspersed with ridges of enamel grouped together in an elegant pattern, and arranged for the most part in a longitudinal direction. The lower jaw has a single row of small close set tubercles on its median line. In advance of the blunted extremity of the symphisis of the rami, a single, solid, conical osselet is articulated, forming the apex of the lower jaw. This peculiar structure is common to all the species of *Aspidorhynchus*, but does not, so far as I am aware, occur in any other genus. The orbit is large, and situated near the angle of the jaws. The latter are furnished with a formidable array of sharp incurved teeth. Those of the lower mandible appear in the specimen figured to have been the largest; but a portion of an upper jaw in my possession leads me to conclude that the armature of the upper maxillary bone was not at all inferior in power to that of the lower maxillary. All the teeth appear to be quite smooth. The opercular apparatus is defective. The operculum is wanting, but owing to this, perhaps lucky, accident, the bronchial arches are exhibited; parts rarely preserved in the fossil state. The sub-operculum is small, and apparently smooth. The pre-operculum, on the contrary, is large, and ornamented on its lower limb with a row of distinct plaits of enamel. The posterior angle is nearly a right angle. The pectoral fins are much mutilated; they appear to have been small, and to have been supported by a feeble thoracic arch. The ventral fins are also much broken. They are situated 8 inches from the snout, and 5 from the tail. The rays composing them are broad, and the transverse articulations are numerous. The anal fin is inserted $2\frac{1}{4}$ inches from the base of the caudal fin. The anterior rays are long, and bifurcated at their extremities, but the succeeding ones decrease rapidly in length, giving a slender and pointed character to the fin. The number of rays is uncertain, but they seem to have been not fewer than 14 or 15. The dorsal is the most remote of all the fins, its origin being

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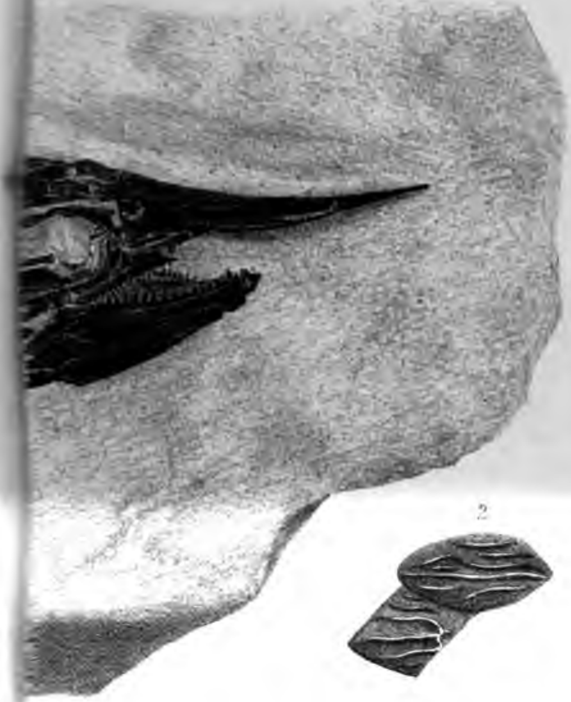
* Poiss. Foss. vol. ii. page 14.

DECADE 8 PL 6

ASPIDORHYNCHUS.

(Oolitic)



2

Day & Son Lith^rs to the Queen

only 2 inches from the commencement of the tail. This backward position of the dorsal fin is a feature found in all the *Aspidorhynchi*, but in the species under description it obtains its maximum eccentricity. The scales are for the most part exposed on their under-surface. The principal series, or that traversing the middle of the flank, is composed of scales about half an inch in depth. This is succeeded above and below by several series of much smaller dimensions. The substance of all the scales is thinner than in any of the oolitic species, and the articulating rib on the inner face is less prominent. The outer surface of the scales, with the exception of those along the back of the fish, is smooth and devoid of ornament. The dorsal series, however, is characterised by strongly marked crests of enamel, arranged in continuous lines in the longitudinal direction of the scales. These ridges are most prominent in front of the dorsal fin. The tail is slender and deeply forked, forming an appropriate finish to the graceful outlines of this, one of the most elegant denizens of the waters in which it lived.

Locality.—The Dorchester Museum possesses two specimens of this rare fish, procured by Mr. Wilcox, of Swanage, from the quarries of Purbeck stone in that vicinity. I have named it in compliment to the Rev. Osmund Fisher, owing to whose exertions the town of Dorchester is in possession of a very thriving museum, and through whose kindness I have had the opportunity of examining all the valuable materials in that depository.

EXPLANATION OF PLATE.

Fig. 1. Aspidorhynchus Fisheri, size of nature.
Fig. 2. Dorsal scales, magnified.

P. DE M. GREY EGERTON.

June 1853.

BRITISH FOSSILS

[illegible]

[illegible]

[illegible]

us PHOLIDOPH[illegible] [illegible]
Gonlolepidoi. Family [illegible]
elongated, more or less fusiform [illegible]
ked; the lobes equal [illegible]
on.]

SONYM.—*Pholidophorus H*[illegible]

scription.—This [illegible]
us was named by Mr [illegible]
pliment to the discoverer [illegible]
pecies has yet been published [illegible]
e subject for this Decade. [illegible]
genus; the largest of all the [illegible]
eding 2 inches in length. [illegible]
and great solidity of the scales. [illegible]
representation is not so complete as [illegible]
best idea of the form and characters [illegible]
ures which are for the most part [illegible]
other examples. It differs remarkably [illegible]
lidophori in the thick and short-set proportions [illegible]
ch respect it contrasts strongly with the [illegible]
lidophorus gracilis of Count Münster—the [illegible]
erto described. The head measures rather less than [illegible]
the entire length, and is about equal to the largest diameter of
body. The muzzle is pointed, and the gape wide. The bones
[illegible] head and opercular appendages are smooth and lustrous.
[illegible] to the maxillary apparatus are more or less
[illegible] by fine longitudinal plaits running parallel
[illegible] of the [illegible] The surface of the lower
[illegible] rge punctures
[illegible] rnished with

a single row of smooth thick-set villiform teeth. These are well seen in the enlarged representation of a detached head (fig. 2 of the Plate). The pre-operculum is more uneven superficially than the associated bones, the undulations becoming very strongly marked as they approach the posterior margin, which, however, is not incised. The operculum is triangular, the apex directed downwards; the sub-operculum is nearly as large as the operculum, and both are traversed by indistinct concentric lines of growth. The scales conveying the mucous duct are quadrilateral in the anterior and middle parts of the body, but as they approach the tail the posterior angles are bevelled off, and the long diameter of the scales gradually reduced until they assume the lozenge form. The canal is unusually large, and its course is prominently raised above the surface of the scales. The apertures are for the most part in notches at the posterior margins, but occasionally there is, in addition, an orifice in the centre of the scale. The scales immediately below the lateral line are the largest, and are also quadrangular. Those below this series, as also those above the lateral line, diminish rapidly in size, and lose at the same rate their angular outline. The surfaces of all the scales are perfectly smooth, and invested with a dense covering of ganoine. The free margins of the larger scales are armed with two or three sharp cusps, but in the smaller scales these are either reduced to a single point or are altogether absent. The fins are mutilated in all the specimens. The pectoral fins appear to have been broad, and to have contained not less than 16 rays. The position of the dorsal fin is rather remote. The ventrals are small, and are placed about the middle of the body; the anal fin is about the dimensions of the dorsal fin, and is situated nearer to the ventrals than to the tail. The latter fin is not preserved in any of the specimens.

Locality.—All the specimens yet discovered of this and the two following species of fossil fish, where found by Mr. Higgins in a single block of Cotham marble from the lower lias of Aust Passage There are not less than 14 or 15 individuals all grouped together in a matrix not larger than the plate which accompanies this description. Owing to the liberality of the discoverer, specimens of this species are in the collections of the Bristol Institute, the Rev. P. B. Brodie, the Earl of Enniskillen, and my own; and I am indebted to him and the other possessors for the loan of their specimens for the purpose of comparison and description.

PLATE VII. Fig. 6—8.

Pholidophorus nitidus. SP. NOV.

Description.—Associated with the preceding group of fish, two specimens were found, which although very imperfect, incontestably constitute a new and distinct species of *Pholidophorus.* Among the numerous members of this overcharged genus, many of which are remarkable for graceful forms and proportions, none can vie with the subject of this memoir for symmetry and elegance. As compared with *Pholidophorus Higginsi,* the head is smaller, the body more slender, and the shape and proportions of the scales dissimilar. The imperfection of the specimens precludes a very detailed description of the species, at the same time enough remains to establish specific characters which may be safely relied on. One specimen, belonging to the Bristol Institution, shows the impression of a portion of the head and the opercular apparatus. It was evidently small in relation to the body, and the surface of the bones was smooth and highly polished. The other specimen, of which a representation is given double the natural size, belongs to Mr. Higgins. It shows the greater part of the trunk, together with the dorsal and one ventral fin. These are situated opposite each other, and are composed of a small number of fine fin rays. The scales are beautifully preserved, without either dislocation or fracture, and present the following characters. The principal series, or that constituting the lateral line, contains the largest scales. They are oblong in form, being considerably higher than they are wide. The posterior angles are slightly rounded. The central area of each scale is traversed by a ridge indicating the course of the mucous tube, and in addition to the notch at the posterior margin for the exudation of the lubricating secretion, there is also on each scale a foramen on the upper margin of the tube (Plate 7. fig. 7.) The row of scales immediately below the lateral line is next in importance. In this set the vertical diameter is much reduced, and in the succeeding rows, about four in number, this diminution is progressive, the scales in the vicinity of the ventral fins being nearly equilateral. Above the lateral line one row of large scales occurs, and this is succeeded by four or five rows in which not only are the dimensions exceedingly reduced, but the posterior margins, by the elongation of the lower angles, assume the lozenge form. They are all highly lustrous, and the only irregularities of surface discernable with a pocket lens are the concentric undulations recording the successive growths of the scales.

Locality.—These specimens were found in the same block of Cotham marble at Aust as those described in the preceding memoir.

PLATE VII. Fig. 9—12.

LEGNONOTUS. GEN. NOV.

[Genus LEGNONOTUS (λεγνον, a fringe, νωτος, the back). EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci.) Dorsal fin extending from the nape to the tail; teeth conical.]

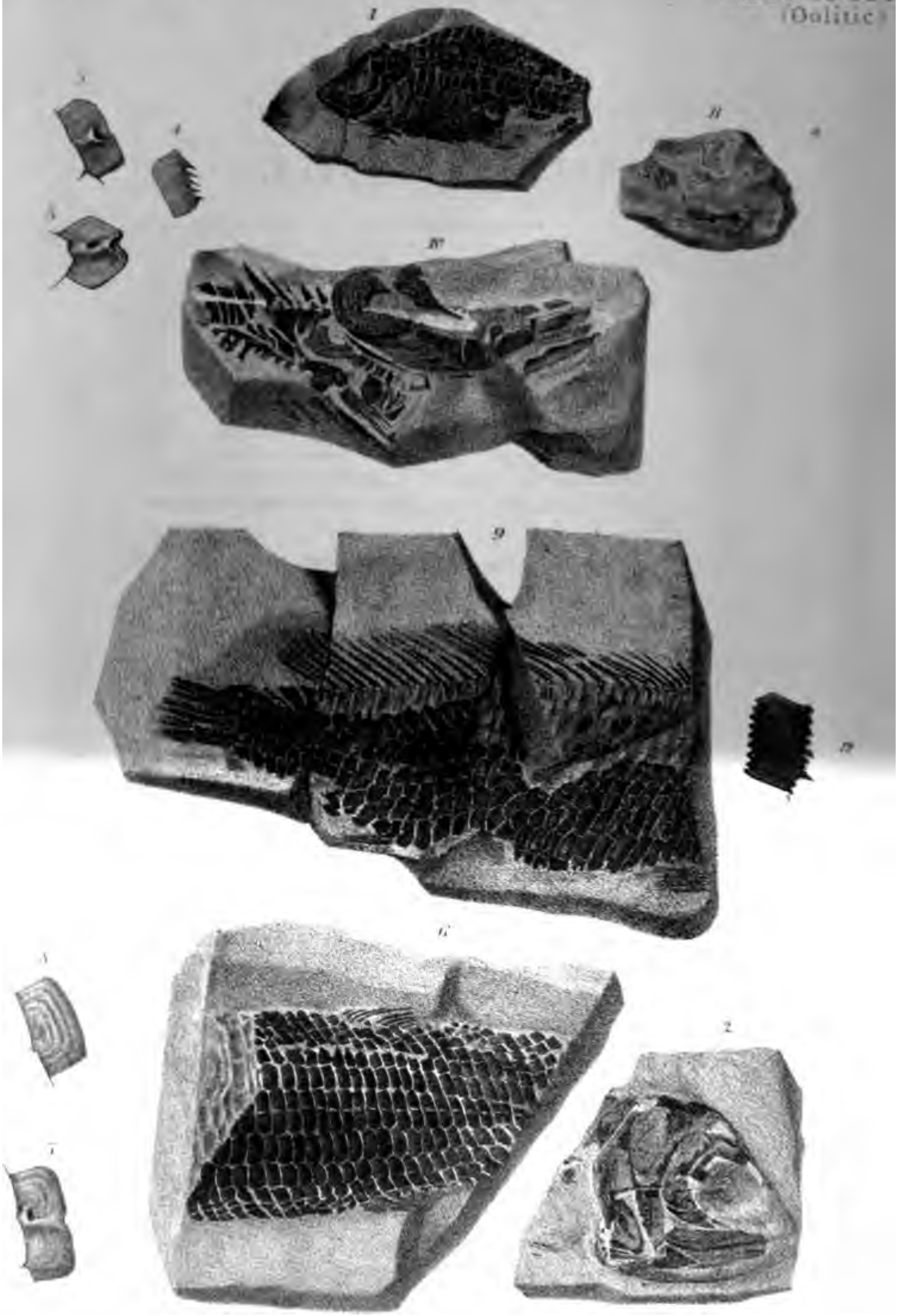
Legnonotus Cothamensis. SP. NOV.

Description.—The same block of Cotham marble which contained the two preceding species, yielded also the curious little fish represented in the accompanying plate (fig. 9.), of twice the natural size. The head and detached jaw, of which enlarged views are given at figs. 10. and 11., probably belonged to the same species, at all events they differ entirely from the characters of *Pholidophorus*, the only other genus associated with them. It is not without some hesitation that I have ventured on the slender evidence afforded by a mutilated specimen, and a few fragments to establish a new genus; and I should not have done so, could I by any licence of interpretation of the characters of genera already acknowledged have referred this fish to any one of them. The dorsal fin is a feature of such paramount importance, that it cannot be disregarded; and the peculiarities of this organ in the subject before us, are quite irreconcileable with any genus hitherto discovered. It commences immediately behind the nape and extends nearly to the tail, and contains about 30 rays all supported on strong perpendicular interapophyses. Six or seven of the anterior rays are single spines, rather arched and shorter then the succeeding rays. The latter are thicker than the anterior ones, and although single for some distance from the body, are subdivided at their extremities and traversed by transverse articulations at rather distant intervals. The nearest approach to this construction of the dorsal fin is found in the Sauroid genus *Macrosemius*, but in other respects *Legnonotus* resembles a *Pholidophorus*, or still more nearly the genus *Notagogus*. The former has a small single fin on centre of the back, the latter has a double dorsal fin; features quite sufficient to distinguish them from the subject before us. The fish measures 1½ inch from the insertion of the pectoral fin to the base of the tail, and $\frac{7}{10}$ of an inch in depth. The dorsal fin occupies an inch of the back, and the anal fin is nearly an inch distant from

eological Survey of the United Kingdom.

DECADE 8. PL.

PHOLIDOPHO
LEGNONOTU
(Oolitic)



-5. PHOLIDOPHORUS HIGGINSI *Stutchbury* 9-12 LEGNONOTUS COTHAMENSIS. *Eger*
PHOLIDOPHORUS NITIDUS — *Egerton*

the pectoral fin. These fins are both small, and the rays continue the greatest part of their length without subdivision; they are, however, fimbriated at their extremities. The scales are very thick and solid, and of variable and rather irregular forms. The ganoid investment is very dense and lustrous. The posterior margins are coarsely serrated. A large fulcral scale occupies the base of the upper lobe of the tail. The latter organ is mutilated, but it is probable from what remains, that it was blunted in form, or at all events not deeply forked. The lateral line is nearly horizontal. The head figured as probably appertaining to this fish shows the operculum and the lower jaw. The former is characterized by a rough pattern of flattened tubercles of enamel, very different in this respect, as also in form, from the corresponding part in the genus *Pholidophorus*. The lower jaw is strong, and armed with a single row of stout incurved teeth, in the form of elongated cones, with rather blunt points, not unlike the outer row of teeth of some of the more slender toothed *Lepidoti* or *Æchmodi*. They are well seen in a detached jaw represented at fig. 11 of the plate. On comparing this figure with the *Pholidophorus* head (fig. 2.), the difference of the dentition of the two genera is easily appreciated.

Locality.—This Ichthyolite was discovered by Edmund Thomas Higgins, Esq., at Aust, in the same block of Cotham marble which contained the two species of *Pholidophorus* figured on the same plate. It is in his possession, and I am indebted to his liberality for the opportunity afforded me of making it available for this Decade.

EXPLANATION OF PLATE.

Fig. 1. Pholidophorus Higginsi, size of nature.
Fig. 2. Head of ditto enlarged, twice the size of nature.
Figs. 3. 4. 5. Scales of ditto, 4 times the size of nature.
Fig. 6. Pholidophorus nitidus, twice the size of nature.
Figs. 7. 8. Scales of ditto, 4 times the size of nature.
Fig. 9. Legnonotus Cothamensis, twice the size of nature.
Fig. 10. Head of ditto ditto ditto.
Fig. 11. Lower jaw of ditto ditto ditto.
Fig. 12. Scale of ditto, 4 times the size of nature.

P. DE M. GREY EGERTON.

July 7, 1853.

BRITISH FOSSILS.

DECADE VIII. PLATE VIII.

PTYCHOLEPIS CURTUS.

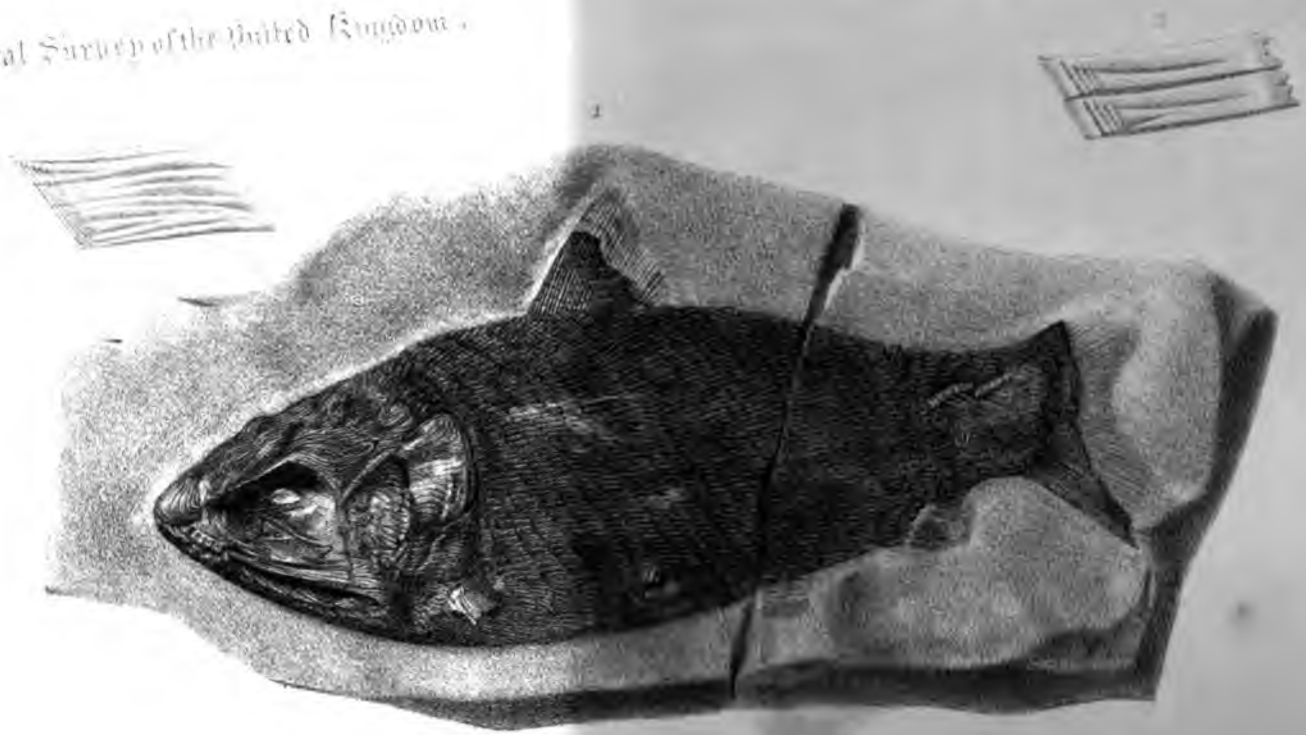
[Genus PTYCHOLEPIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Scales thick, elongated, plicated transversely on the base, and deeply furrowed longitudinally; under-surface smooth, and devoid of rib; pectoral fins pointed; dorsal fin opposite the ventral fins; anal fin remote.]

***Ptycholepis curtus*, SP. NOV.**

Description.—The beautiful little specimen figured in the plate accompanying this description affords another proof (were further evidence requisite) of the value of dermal characters in the determination of fossil fishes, more especially those of the secondary formations, where the internal skeleton is so rarely preserved. Were a mere outline of the fish before us submitted even to Professor Agassiz himself, I very much doubt whether he would recognize or acknowledge in it a species of his genus *Ptycholepis,* so little do its short and thickened proportions resemble the slim, elegant forms of the Sauroid family in general, or correspond with the known species of its own genus; and yet the inspection of a single scale, or even a fragment of one, would at once reveal to him its true generic affinity. The fish has retained its natural form without distortion of the body or dislocation of its parts. The pectoral, ventral, and a portion of the caudal fin are wanting; with these exceptions, it is in perfect preservation. The length from the nose to the insertion of the tail is $4\frac{3}{4}$ inches, of this measurement the head occupies nearly $1\frac{3}{4}$ inches, more than a third of the entire length In *Ptycholepis Bollensis,* the head measures only a fourth of the total length. The depth of the body at the dorsal fin is $1\frac{7}{10}$ inches. These proportions serve to distinguish this from the previously known species; they are, however, associated with other distinctive features to be mentioned in the sequel. The head, as noticed above, is large; the outline forms a very regular isosceles triangle. The orbit is of moderate size, and placed in a forward position. The snout is thickened and rounded at its extremity. The mouth is large, and capable apparently of great distention. The operculum is quadrilateral, and the sub-operculum triangular. The line of junction between them runs obliquely upwards and backwards The posterior border of these bones is nearly perpendicular. All the cranial bones and their appendages are highly ornamented by deep grooves, arranged in a variety of elegant patterns. On the upper part of the head they are grouped longitudinally, running in sinuous, and sometimes inosculating lines, from the occiput to the snout. On either side the latter, they are retroflexed with a sigmoid curve, exactly resembling the common tattoe pattern on the alæ of a New Zealander's nose. On the premaxillary bone they are parallel to its lower margin, and on the lower jaw they run obliquely downwards and backwards. The opercular bones are less deeply sculptured, and the furrows are more distant. On the posterior angles they become almost obsolete. The scales (with the exception of a few immediately behind the thoracic arch) (Plate viii. fig. 2.) are long and narrow. The base of each is marked by three or four distinct bars. The surface of each scale behind the base is cut by two (or sometimes more) grooves, always varying in length, but rarely extending to the posterior edge of the scale, which is deeply notched. They are all incrusted with a thick and lustrous coat of ganoine. The anterior insertion of the dorsal fin is equidistant from the nose and the commencement of the tail. The fin itself is moderately long, and contains 22 rays. Of these the sixth and seventh from the front seem to be the longest. The transverse articulations of the rays are very frequent near the base, but become more and more distant. After the fourth articulation the rays are grooved, but they do not dichotomise, so far as the fin is preserved in the specimen. It is devoid of fulcral scales. The base of the pectoral fin is all that remains of this organ. The anterior rays are disproportionately strong. The ventral fins are deficient, but they seem from the impression on the shale to have been small. They are inserted below the hinder part of the dorsal fin. The anal fin is small, and very distal in position. Its hinder rays almost reach the tail. The latter is of moderate size, and forked. It has a strong fringe of oblique rays along its upper margin, and a similar one, though finer, protects the lower edge. A few of the terminal vertebræ of the column are preserved. They diminish gradually in size, and terminate at the commencement of the upper lobe of the caudal fin.

Geological Survey of the United Kingdom.

(Oolite)



PTYCHOLEPIS CURTUS.— *Egerton.*

[illegible] Del.

Dinkel lith.

Affinities.—The dermal characters of this species associate it very closely with *Ptycholepis Bollensis;* the individual scales, however, are proportionately longer and narrower, and differ in the arrangement of the sculpture. I have evidence of a third species occurring with the two former, in the lias of Lyme Regis, in which the scales are still more elongated; but the subject of the present memoir is easily distinguished from the other members of the genus, by the striking proportions of the fish described above.

Localities.—The only specimen I have seen of this species was found in the lias beds, between Lyme Regis and Charmouth. It is the property of Mr. Beccles, of St. Leonards-on-Sea, to whom I am indebted for permission to figure and describe it.

EXPLANATION OF PLATE.

Fig. 1. Ptycholepis curtus, size of nature.
Fig. 2, 3. Scales magnified.

P. DE M. GREY EGERTON.

May 1853.

BRITISH FOSSILS.

DECADE VIII. PLATE IX.

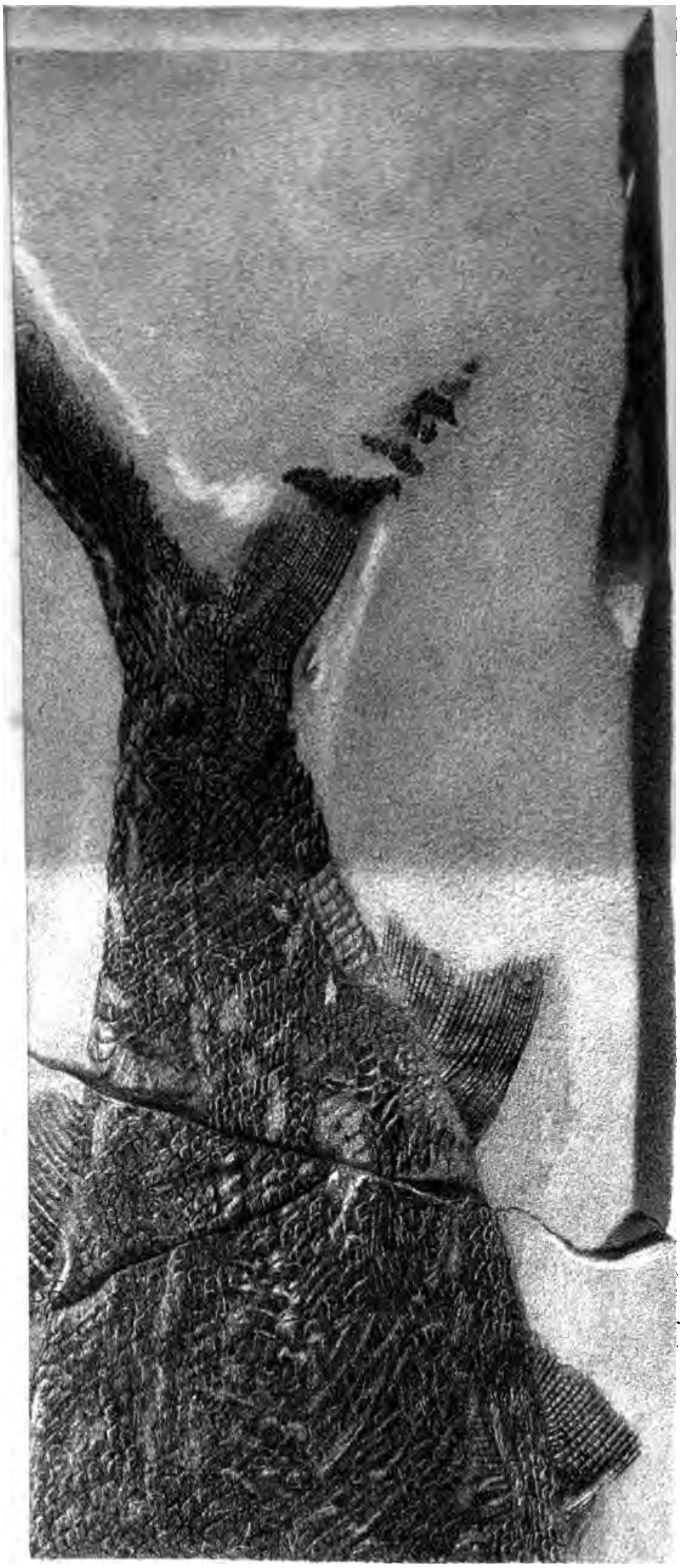
OXYGNATHUS. GEN. NOV.

[Genus OXYGNATHUS. EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group. Tail forked.) Body elongated; head pointed; jaws furnished with numerous small incurved teeth, intermixed with larger ones; scales thick, small, rhomboidal, and covered with sinuous longitudinal furrows; pectoral fins short and broad; ventral fins large; anal fin small.]

Oxygnathus ornatus, SP. NOV.

Description.—This fish has so many striking peculiarities, that it has been necessary to create a new generic title for its designation. The slender lanceolate form of the body resembles some species of *Eugnathus*, the characters of the teeth and jaws approach those of *Sauropsis*, while the peculiar ornamentation of the scales can only be compared to that found in the heterocerque genus, *Acrolepis*. The combination of these characters, and the addition of others not found in the above cited genera, establish the propriety of selecting for this form a new generic appellation. The specimen measures 9½ inches, from the snout to the base of the caudal fin, of which the head occupies 3 inches. The greatest depth of the body was probably not more than 2 inches, but the attitude of the fish is such that this measurement cannot be ascertained with precision. This, however, is clear, that the deepest part was immediately behind the nape, from which point the body gradually tapers to the tail. The dorsal and caudal fins are both absent. The form of the head is more pointed than in any of the Sauroid genera, except those with elongated muzzles, such as *Aspidorhynchus*, *Belonostomus*, and *Saurichthys*. In consequence of the extreme tenuity of the bones of the head few are preserved entire, with the exception of the dentigerous bones, and the hyoid and branchiostegous apparatus. These are all covered with a surface ornament, composed of fine vermicular plaits of enamel, arranged for the most part in longitudinal directions. The remnant of one of the opercular bones shows that this pattern did not extend to those bones; they seem, however, to have been covered with a fine and rather indistinct granulation, intermixed with raised lines, running parallel to the posterior margin of the flap. The teeth are numerous in both jaws. The larger ones are conical, sharp, and hooked at the extremity. The smaller ones are of the same form, and fill up the irregular interspaces between the larger ones. They together form a single row, fringing the margins of the mouth. The symphisis of the lower jaw is remarkably acute. The branchiostegous rays are beautifully displayed, occupying the angle between the jaws. There appear to have been about twelve on either side. The pectoral fins are composed of a series of flattened rays, about thirty in number. They are devoid of transverse articulations, but dichotomise when near their extremities. The ventral fins are situate nearer to the anal than to the pectoral fins. They are smaller than the latter, although larger than the corresponding organs in the allied genera. They contain, in addition to three or four small marginal appendages, about 24 rays. These are rounded, have frequent transverse articulations, and bifurcate at their extremities. The anal fin is short and small. It occupies a position midway between the anterior insertion of the ventral fins, and the commencement of the tail. It contains 16 or 18 rays of similar character to those composing the ventral fins. The scales are small, and very numerous. They vary in form and size, on different parts of the body, but they all correspond in the character and distinctness of the surface ornament. This consists of elevated ridges of enamel, arranged for the most part in longitudinal directions, in reference to the outline of the fish, but obliquely as regards the individual scales. On the nape a few granulations are interspersed with the ridges. The latter, however, predominate in all other regions of the body. The scales near the tail are thicker than those on other portions of the trunk, and the ornament more coarse. Each scale has a thick rib on its under surface, which locks in reciprocally with that of the adjoining scale, and secures the continuity of the series against accidental dislocation.

Affinities.—The character of the scales alluded to above marks out the genus *Oxygnathus,* as distinct from all others. The only approach to it is in the genus *Acrolepis,* but (in addition to the latter being a heterocerque fish, which alone would forbid the union,) the differences in the form of the scales, and the arrangement of the sculpture, sufficiently distinguish it from that genus. A slight re-



semblance may, perhaps, be traced between these scales and those of *Gyrolepis;* but, here again, we have probably a heterocerque fish, it being restricted to beds older than the lias. As compared with the Liassic Sauroid genera, already described, this fish differs from them all, nor can it be ascribed to any of those genera named, but not yet described, viz., *Thrissonotus*, *Centrolepis*, *Endactis*, or *Cosmolepis.*

Locality.—The figure and description are taken from a specimen in the collection of the Earl of Enniskillen, found in the lias at Lyme Regis.

EXPLANATION OF PLATE.

Fig. 1. Oxygnathus ornatus, size of nature.
Fig. 2, 3, 4. Scales of ditto, magnified.

P. DE M. GREY EGERTON.

May 1853.

BRITISH FOSSILS.

DECADE VIII. PLATE X.

PYCNODUS LIASSICUS.

[Genus PYCNODUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Ganiolepidoti. Family Pycnodontidæ.) Body short, deep, and adpressed; three or five rows of smooth, flattened, oblong, tritoral teeth, on each ramus of the lower jaw; five rows of similar teeth on the vomer; incisive teeth in both jaws.]

Pycnodus liassicus, SP. NOV.

Description.—The announcement of the occurrence of fishes belonging to the family *Pycnodontidæ*, in the lias of Great Britain and Wurtemberg, recently made in a memoir read at the Geological Society,* has been quickly followed up by the discovery of a true *Pycnodus*, from the same formation. This interesting specimen was brought to light during the operation of transferring the fine collection of fossil fishes in the British Museum, from the cases in Room 6, to their new position in Room 2. It is supposed to have been derived from the lias of Barrow-on-Soar, and, although far from perfect, is, nevertheless, sufficiently so to leave no doubt as to its natural affinities. In referring it to the genus *Pycnodus*, I have been guided mainly by the characters of the dentary apparatus. The general contour of the body has more resemblance to a *Microdon*, or a *Gyrodus*, and wants the elongated caudal pedicle of the typical *Pycnodi*; but the characters of the teeth are so decisive, that I have no hesitation in referring it to the latter genus. The specimen figured in the plate measures from the symphisis of the lower jaw to the commencement of the tail, 4 inches. The greatest depth, following the direction of the dorso-ventral series of scales, is 3½ inches. The anterior portion of the trunk is highly vaulted; the summit of the nape being nearly 1 inch higher than the occiput. The frontal and facial line is straight, and steeply inclined. The lower jaw is unusually large (fully 1 inch in length), and renders

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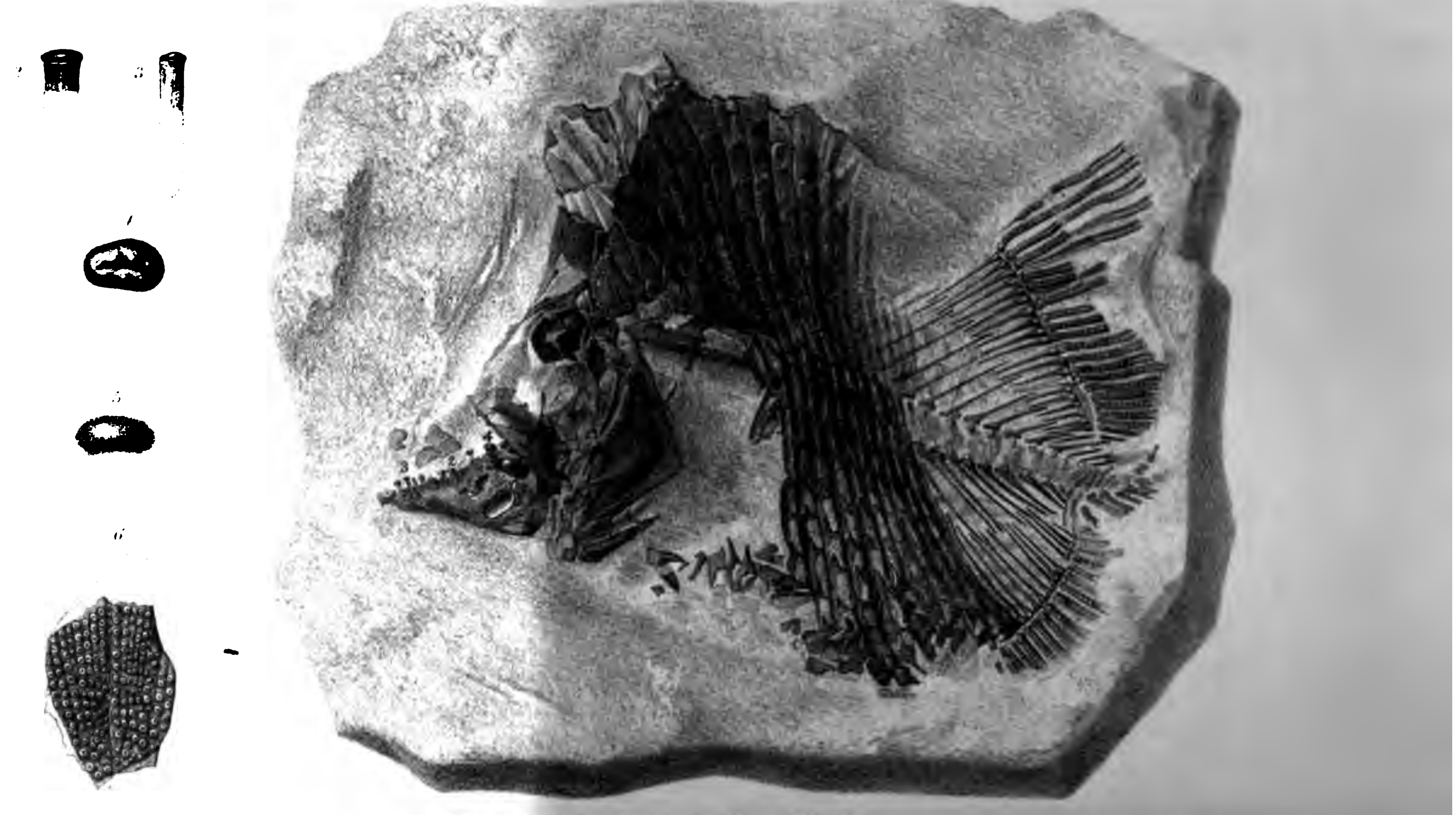
*** Quarterly Journal of Geol. Soc., 1853, page 276.**

the prognathic character very decided. The orbit is situated in a high and very forward position. The upper limb of the operculum is nearly horizontal; the posterior margin slopes downwards and forwards, in an easy curve. The preoperculum is high and narrow. Wherever the surface of the cranial bones is preserved, it is covered with small flattened granules, distinct from each other, and not grouped in radiating or other patterns. The anterior or incisive teeth are elongated cones, slightly flattened at the apices; the succeeding teeth are shorter and broader. The outer row only is visible, and these being comparatively small, we may conclude from the general rule applicable to this genus, that each ramus had five rows of teeth, those comprised in the second row being considerably larger than the remainder. One large tritor is seen in a position which indicates that it belonged to the central or principal row of the vomerine teeth. Several smaller ones scattered about may have belonged to the lateral series, of which there were probably two on either side of the central one. The form of all these teeth is more or less oblong, and the crowns are smooth, devoid alike of the inequalities of the *Microdon* teeth, and the rugosities of the *Gyrodi*. The dorsal and anal fins are large, and opposed to each other. The former has 20 rays, the latter about 15. These are all articulated to dilated extremities of strong interapophyseal osselets. The rays are single at first, but they soon dichotomize, and are marked by very closely arranged transverse articulations. The course of the spinal column is nearly straight, and does not coincide with the arched form of the dorsal outline. The vertebral centra were cartilaginous, but the apophyses strong and bony. The scales are much mutilated. Those of the nuchal region are the largest. The impression left on the stone proves them to have been ornamented with diverging curved lines of small tubercles, sweeping downwards and outwards from the central area of each scale. The succeeding scales below are of smaller dimensions, but they all partake of the high narrow character so generally prevailing in this family. They are covered with small flattened tubercles, similar to those found on the bones of the head. No evidence remains of the form or position of the pectoral or ventral fins. It has been stated above that the form of this fish differs from that recognized as typical of the genus *Pycnodus*, but this remark must be taken as having reference to the state of our knowledge of the genus. Agassiz founded its generic attributes on the well-known *Pycnodus platessus*, of the Monte Bolca beds, and in this tertiary form the elongation of the pedicle of the tail is very striking. The only

Geological Survey of the United Kingdom.

(Oolitic)



PYCNODUS LIASSICUS — *Egerton*.

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[illegible]

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other species of which the trunk is preserved, with the exception of the species of *Pycnodus orbicularis*, in the Paris Museum, is the small *Pycnodus rhombus*, found in the Jura (?) beds of Torre d'Orlando, near Castel-à-Mare; and in this older form this peculiar character is less prominent. The remaining thirty-two species enumerated and partly described in the "Poissons Fossiles," ranging from the tertiary formation down to the Keuper, are only known by their teeth. It is, therefore, quite possible that the Oolitic species may have resembled the other *Pycnodonti* of that period, in the more rounded outline of the body, and that this must therefore be considered a specific rather than a generic condition. Be this as it may, the characters derived from the dentition are of so much greater moment than the mere outward form of the fish, and they coincide so entirely with those of the well-known dental apparatus of the genus *Pycnodus*, that no doubt remains upon my mind as to the propriety of assigning the subject of this article to that genus.

Locality.—The only specimen I have met with of this species is the one represented in the plate.

EXPLANATION OF PLATE X.

No. 1. Pycnodus liassicus, size of nature.
Nos. 2, 3. Front teeth, magnified.
Nos. 4, 5. Vomerine tritor, ditto.
No. 6. Nuchal scale, ditto.

P. DE M. GREY EGERTON.

July 7, 1853.

SUPPLEMENT TO DECADE VIII.

THE delay which has occurred in the publication of this Decade has been so far fortunate, that in the interval which has elapsed since the completion of the manuscript, several specimens have been discovered, of species described therein, substantiating the characters already given, and supplying others which were deficient in the materials originally examined. As several of the species were founded upon single specimens, it is of consequence that the opportunity of recording this additional evidence should not be lost, although it would not be advisable to incorporate it in the descriptions completed two years since, and which are now in type.

ARTICLE V. PLATE V.

Histionotus angularis.—This genus and species was determined by a single specimen, in my own collection. The Museum of Practical Geology has now two specimens of the genus, one of which belongs, no doubt, to the same species. The other is a portion of a much larger fish, and may possibly indicate a second species, but it is too imperfect to afford any reliable evidence of distinctive character. Both these specimens are from the Swanage quarries.

ARTICLE VI. PLATE VI.

Aspidorhynchus Fisheri.—The British Museum and the Museum of Practical Geology now possess good specimens of this species. The original of Plate 6 is so perfect, that no further evidence was necessary to complete the specific description.

ARTICLE X. PLATE VIII.

Ptycholepis curtus.—This species depended on the evidence of a single specimen, in the possession of Mr. Beccles. A second specimen has recently been sent to me from Lyme Regis (whence the first was also derived), showing some details which were wanting in the one originally described. The pectoral fins are here preserved. They are composed of from 18 to 20 rays each. These are strong, and closely arranged. They are single as far as they are preserved, and show no transverse articulations. The anterior margins of these fins were bordered. The ventral fins are placed nearer to the pectoral than to the anal fins. They are small, and composed of 10 or 12 slender articulated rays ; the articulations only commencing near the extremities. The caudal fin contains about 20 rays in the upper, and 30 in the lower lobe. The former is strengthened by a ridge of elongated scales, overlapping its base. Five or six of the upper fin rays are much stronger than the succeeding ones, and have no transverse articulations until near their extremities ; the remaining rays of the upper lobe, and all those composing the lower lobe, have very frequent articulations from the base to the extremity. The length of this specimen is 5¼ inches from the nose to the commencement of the caudal fin ; the depth from the nape, 1¾ inches. The length of the head from the nose to the posterior edge of the operculum, 2 inches.

Article XI. Plate IX. and IX*.

Oxygnathus ornatus.—The fortunate discovery of a most perfect example of this rare fish enables me to complete the description of those parts that are either mutilated or wanting in the specimen originally examined. The recent acquisition measures 11 inches from the snout to the fork of the tail, and 3 inches in depth between the nape and the dorsal fin. The position of the fish is such that all the fins of the left side are shown, and by a lucky upturning of the lower jaw, both rami, together with the hyoid and branchiostegous apparatus are displayed. The parts shown in this specimen, which were deficient in the former one, are the dorsal and caudal fins. The more perfect condition of the anal fin renders some correction requisite in the description formerly given of this organ. It is, in fact, not so small as I was led to suppose, but is in full proportion to the other locomotive organs. It commences anteriorly with a few graduated jointed rays, and not with the single fulcral rays frequently found in this position ; these are succeeded by the principal rays, about 30 in number, which decrease in length rapidly as they recede towards the tail. The transverse articulations of the principal rays are frequent near the base of the fin, but occur at greater intervals on the more distant portion ; on the posterior rays they are also frequent, but uniform throughout. The dorsal fin is situated immediately above the interspace between the ventral and anal fins. It was furnished, like the anal fin, with a few soft slender rays on the anterior margin. The succeeding rays correspond also in size and character with those of the anal fin. In consequence of a slight mutilation of the hinder extremity of the fin, the exact number of the rays cannot be ascertained ; it was certainly not less than 30. The most remarkable and wholly unexpected character of this fish is presented by the form and structure of the caudal fin. This organ is deeply cleft into two lobes ; the upper one measures 3½ inches in length, the lower one only 2½. The former has a scaly investment from the base to the extremity, below which issues a fringe of innumerable fine rays, with frequent transverse articulations and longitudinal bifurcations. The lower lobe contains about 24 rays ; of these the strongest occupy the middle of the lobe, those of the upper and lower margins becoming gradually finer as they recede from the centre. The transverse joints are nearly equidistant, but the intervals are greater than those on the dorsal and anal fins. It results from these peculiarities that this fin in *Oxygnathus* not only simulates the tail of a true heterocerque fish, but carries the resemblance to an extent only found in the most heterocerque genera. I question whether any one on seeing a drawing of this fin would hesitate a moment in pronouncing it a palæozoic form. The solution of this problem depends upon a single point, viz., whether the rays constituting the upper lobe of the tail are all short rays, given off from the lower elements of the vertebral column, or whether any of them are continued under the scaly integument to the upper part of the column. The evidence the specimen affords is this: the centrum in the vertebræ of this genus was ossified, a fact proved by the occurrence of several of these bodies, seen in the specimen, where the integuments have been removed. Being thus qualified to resist decomposition, while the softer parts perished, the course of the spinal column becomes evident by a slight elevation of the surface where the scaly integument rests upon it. In tracing its direction in the posterior part of this fish, it exhibits no tendency to mount into the upper lobe of the tail, as in the typical heterocerque fish, and, to a certain extent, in *Ophiopsis*, *Eugnathus*, and some other homocerque forms; but, on the contrary, it seems to terminate abruptly at the base of the tail. For this reason I am inclined to think that, without more conclusive evidence, it would be unwise to consider this an exception to the general rule, with reference to the fish of the lias, although the actual resemblance of this tail to that of a heterocerque is so striking as almost to warrant a contrary conclusion.

ARTICLE XII. PLATE X.

Pycnodus liassicus.—The opinion I ventured to express in the description of this specimen, that the more shortened contour of the body as compared with the typical *Pycnodus platessus* ought not to exclude it from that genus, has been fully confirmed by the discovery of several new species of *Pycnodus* in the oolitic slates of the Bugey. Monsieur Thiolliere, in one of the most splendid works ever contributed to palæontological literature,* has described and figured, together with other new and interesting forms, five species of this genus. Of these two are more elongated than *Pycnodus platessus*, and of the three shorter species two, viz., *Pycnodus Egertoni* and *Pycnodus Bernardi*, correspond in form with liassic species described in this Decade. There seems to be some doubt as to the locality from which the British Museum example of this fish was derived. In the course of last autumn I saw a second specimen of this species presented to the Worcester Museum by the Rev. W. Symonds, which was found in the lias of the neighbourhood of Tewkesbury.

P. DE M. GREY EGERTON.

April 16, 1855.

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* Descriptions des Poissons Fossiles provenont des Gisements corallines du Jura, dans le Bugey.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE IX.

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1858.

PREFACE.

In issuing this Decade to the Public, justice requires that I should express the great obligations of this Establishment to Sir Philip de Malpas Grey Egerton, who had previously undertaken and completed two similar works at the request of my predecessor, Sir Henry T. De la Beche.

The present Decade contains descriptions and figures of six new genera of Fossil Fishes, three of which had been named by Agassiz, but not described or figured.

In these three Decades of Fossil Ichthyolites, Sir Philip Egerton has described nine new genera and thirty-five species; and in calling attention to his valuable labours, I beg especially to notice the very skilful execution of the Plates by Mr. Dinkel, whose truthful delineations of detail, combined with artistic effect, cannot be surpassed in this branch of Palæontography.

Roderick I. Murchison,
Director.

Museum of Practical Geology,
16*th November* 1857.

BRITISH FOSSILS.

DECADE IX. PLATE I.

COSMOLEPIS. GEN. NOV.

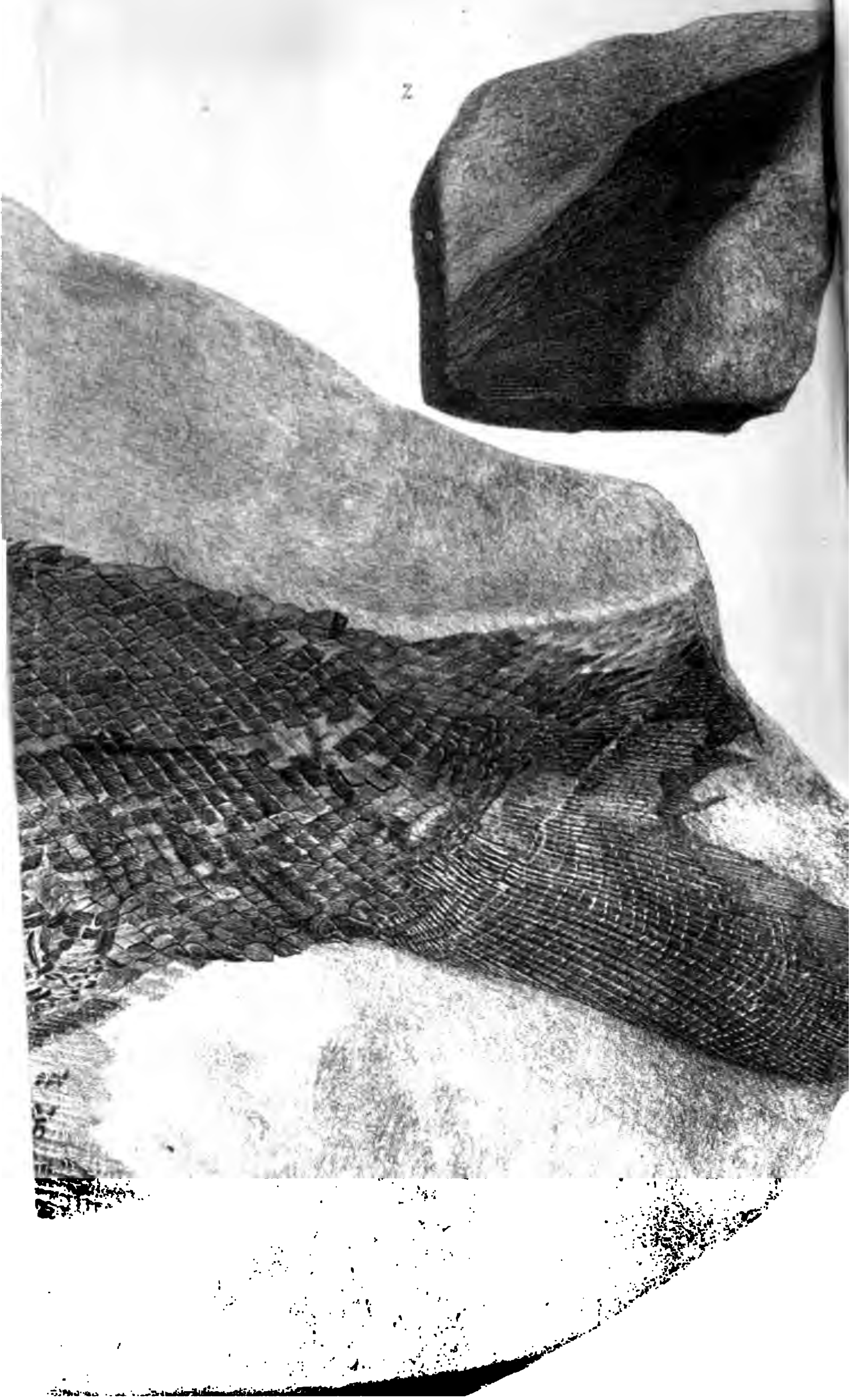
[Genus COSMOLEPIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st group, tail forked.) Body oval. Head small. Scales thick, small, numerous, and rhomboidal; sculptured on their surfaces. Pectoral fins large; ventral fins near the pectorals; dorsal fin in advance of the median line, over the interspace between the ventral and anal fins; anal fin extended; caudal fin large, springing from a broad pedicle.]

SPECIES UNICA. *Cosmolepis Egertoni.* AGASSIZ, MS. *Morris, Cat. Brit. Foss.*, 1854.

In the generic characters here given, I have endeavoured to express those features which distinguish *Cosmolepis* from the several sauroid genera with which it has affinities in other respects. The form of the trunk corresponds with that of *Pachycormus,* the advanced position of the dorsal fin with *Caturus,* the extent of the anal fin with *Sauropsis*, and the character of the scales and caudal fin with *Oxygnathus*. It differs from *Pachycormus* and *Caturus* in having thick sculptured scales, in the form of the tail and in the proportions of the anal fin; from the former in the position of the dorsal fin. It differs from *Sauropsis* and *Oxygnathus* in the greater depth of the trunk in relation to its length, and in the arrangement of the locomotive organs; and from all in the forward position of the ventral fins. The genus was established by Professor Agassiz, immediately before his departure for America, from the examination of a single specimen belonging to Lord Enniskillen, and found in the lias quarries at Barrow-on-Soar. A second specimen has been found since (now in my possession), which agrees in generic and specific details with the original.

Description.—The anterior half of the head is deficient in both specimens; in other respects they are in a good state of preservation. The type specimen is selected for the general description, as being the most perfect, but some of the details are derived from the last found specimen. The form of the body is elliptic, the dorsal and ventral lines forming graceful and symmetrical curves. The pedicle of the tail is slightly prolonged and gradually contracted, but not to so great an extent as in *Pachycormus*. The length of the body from the nape to the base of the upper caudal lobe measures one foot; the greatest depth in front of the dorsal fin is four inches and three quarters; the pedicle of the tail two inches; from the nape to the dorsal fin is five inches, and thence to the tail seven inches. From the pectoral to the ventral fins is three inches and a quarter; from thence to the anal fin, three inches and a half, and thence to the lower caudal lobe four inches. The pectoral fin is composed of about twenty-five rays, the first of which is much stronger than those behind it. The ventral fins are much dislocated; the number of the constituent rays cannot therefore be ascertained. They appear to have been broad, and the rays were thick, flattened, and frequently subdivided transversely. The dorsal fin had a few slight fulcral scales at its base, but neither in this or the other fins is there any evidence of the first ray having a fringed margin. It contained not less than fifty rays, closely arranged, flattened, and composed of very numerous ossicles. The longest, forming the apex of the fin, measure two inches and a quarter in length; from the apex to the hinder margin of the fin the rays decrease rapidly in length, forming with the base line and anterior outline of the fin a nearly equilateral triangle. The rays of the anal fin are too numerous and indistinct to be accurately numbered. They correspond in character with the dorsal rays, but are shorter, and decrease in length more gradually towards the tail. The base of the fin measures two inches and three quarters, and it may be computed to have contained at least seventy rays. The caudal fin is broader and not so deeply cleft as that of *Oxygnathus*, but it corresponds with it in having the upper lobe invested with scales. So strongly marked is this character in both genera, that the doubts I have already expressed in the description of *Oxygnathus* as to the propriety of considering that a homocerque form, are much strengthened by the examination of *Cosmolepis*. The rays composing the caudal fin of *Cosmolepis* are far more numerous and frequently jointed than those of the corresponding organ of *Oxygnathus*. Those of the upper lobe decrease in length and substance as they approach the extremity, and are supported by the prolonged upper limb of the organ, features quite at variance with homocercal structure. There is no evidence in this genus of the prolongation of the vertebral column into the upper limb of the tail; on the contrary, there are symptoms of the abrupt termination of the ossified vertebræ at the fork; it

(Oolite)



may be, however, that the embryonic character was persistent in the hinder extremity of the column, notwithstanding the ultimate development of its other parts. The scales of this fish are remarkable for their great number and the beauty of their sculpture. The dorso-ventral rows on the flanks contain nearly sixty scales in each. Those on the flanks in the vicinity of the line of the vertebral column (which was nearly straight and equidistant from the back and belly) are larger than the dorsal and ventral scales; but on the after part of the body they are all of uniform size. The under surface of each scale has a strong process on the upper margin, which corresponds with a pit on the lower margin of the scale above it; in addition to this, these margins are bevelled, so that additional strength is secured by the overlap of the juxtaposed scales in the dorso-ventral series. The external surface of each scale is ornamented with five or six raised lines of enamel, some single, some bifurcate. These are most frequent on the scales of the anterior parts of the fish, but they are distinctly developed upon all. These dermal characters agree closely with those of *Oxygnathus*. The small portions of the jaws which remain show the bases of strong sauroid teeth; the other parts of the head are deficient.

Locality.—Lias of Barrow-on-Soar, Leicestershire.

EXPLANATION OF PLATE.

Fig. 1. *Cosmolepis Egertoni*, size of nature.
Fig. 2. Tail of another specimen.
Fig. 3. Outer surface of scales, magnified.
Fig. 4. Inner surface of scale, magnified.

P. DE M. GREY EGERTON.

February 1857.

BRITISH FOSSILS.

Decade IX. Plate II.

THRISSONOTUS. Gen. Nov.

[THRISSONOTUS. Agassiz. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group, tail forked.) Body elongated; dorsal fin opposite the interspace between the ventral and anal fins; anal fin extended; scales rhomboidal, small, ganoid.]

Thrissonotus Colei. Agassiz. Poiss. Foss. vol. 2, part 2, p. 128.

The tapering head, gracefully elongated body, and well proportioned fins combine to render this the most elegant of the sauroid fishes of the liassic period. The specimen, which is unique, was discovered many years since, and is in the possession of Lord Enniskillen. The generic and specific appellations were given by Professor Agassiz, who alludes to this specimen in the following paragraph:—"The genus *Thrissonotus* is in some degree intermediate between the genera *Sauropsis* and *Thrissops.* In general appearance it also resembles the *Pachycormi*, but it is decidedly a new type, for the dorsal fin is situated in the middle of the back, and yet it has the extended anal fin of a *Thrissops.*" With reference to these affiliations, I may remark, in corroboration of its generic distinction, that the body is more elongated than in the *Pachycormi*, the dorsal fin more distal, and the scales entirely dissimilar both from that genus and *Thrissops.* The extended anal fin resembles that of *Sauropsis* and *Thrissops*, but the dorsal fin is more advanced than in either of these genera, corresponding more nearly in this respect with the dorsal fin of the genus *Oxygnathus.* The scales have the nearest resemblance to those of the latter genus and *Cosmolepis*, but are devoid of the surface ornament common to those genera.

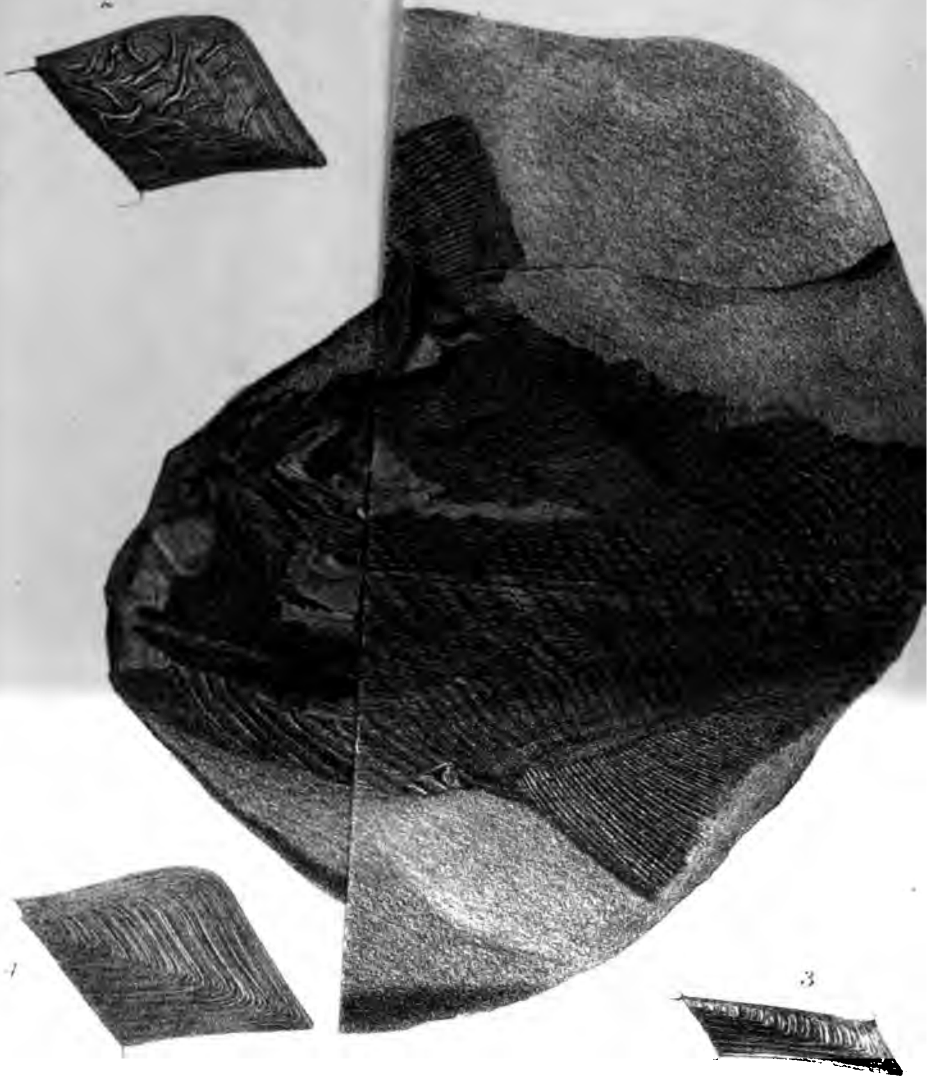
Description.—Lord Enniskillen's specimen, the only one hitherto found, measures ten inches in length. The parts anterior to the eye socket and behind the termination of the anal fin are deficient. The depth is nearly uniform from the nape to the anal fin, being about two inches and a half. Behind the anal fin, the depth is one inch and a half. From the gradual convergence anteriorly of the outlines of the head, it is probable that the muzzle was elongated, after the fashion of an *Eugnathus* or *Sauropsis*. The gape was large, and both jaws were furnished with numerous sharp conical teeth. The branchiostegous rays are flattened, and apparently not so numerous as those of *Pachycormus*. Twelve are distinguishable, of which the middle ones are the broadest. The opercular flap is crescentic in form, and extends some distance behind the line of union of the vertebral column with the occiput. The preoperculum is strong and prominent, and is invested with a thick coat of ganoine, plicated longitudinally. The surface ornament of the operculum and sub-operculum is finer and more granular in its arrangement, and does not conceal the lines of successive growth running parallel to the free margin of the flap. The pectoral fin is broken off at a short distance from the base. It contains about twenty-six rays; these, as far as they are preserved, are single, without transverse sutures. The rays of all the other fins correspond in being compressed and imbricate. The ventral fin has a few short anterior rays, and about twenty principal ones. They are so closely crowded together, that it is impossible to distinguish the precise number. The rays of the dorsal fin are gracefully curved backwards; they are in number about twenty-four. The transverse joints are at distant intervals. The anal fin is remarkable for its extension towards the tail; it measures one inch and three quarters along the base, and probably contains between fifty and sixty rays. The squamation of *Thrissonotus* is very elegant, with regard both to the shape and beauty of the component parts, and the graceful arrangement of the dorso-ventral lines. The scales are all comparatively small, but vary much in relative size. The largest, as is generally the case, occur in the neighbourhood of the lateral line, and the smallest, on the abdominal region. The former are rhomboidal in form, the latter are long and narrow, resembling elongated parallelograms. The surface ornament is, for the most part, due to the permanence of the successive lines of growth; but, in the anterior part of the body, and especially in the vicinity of the nape, a few small vermicular pro-

Geological Survey of the

DECADE IX. PL. 2

THRISSONOTUS

(Oolite.)



jections occur, irregularly scattered over the exposed portions of the scales.

Locality.—Found in a concretion of hard lias at Lyme Regis.

EXPLANATION OF PLATE.

Fig. 1. *Thrissonotus Colei*, size of nature.
Fig. 2. Nuchal scale, magnified.
Fig. 3. Abdominal scale, magnified.
Fig. 4. Caudal scale, magnified.

P. DE M. GREY EGERTON.

February 1857.

BRITISH FOSSILS.

DECADE IX. PLATE III.

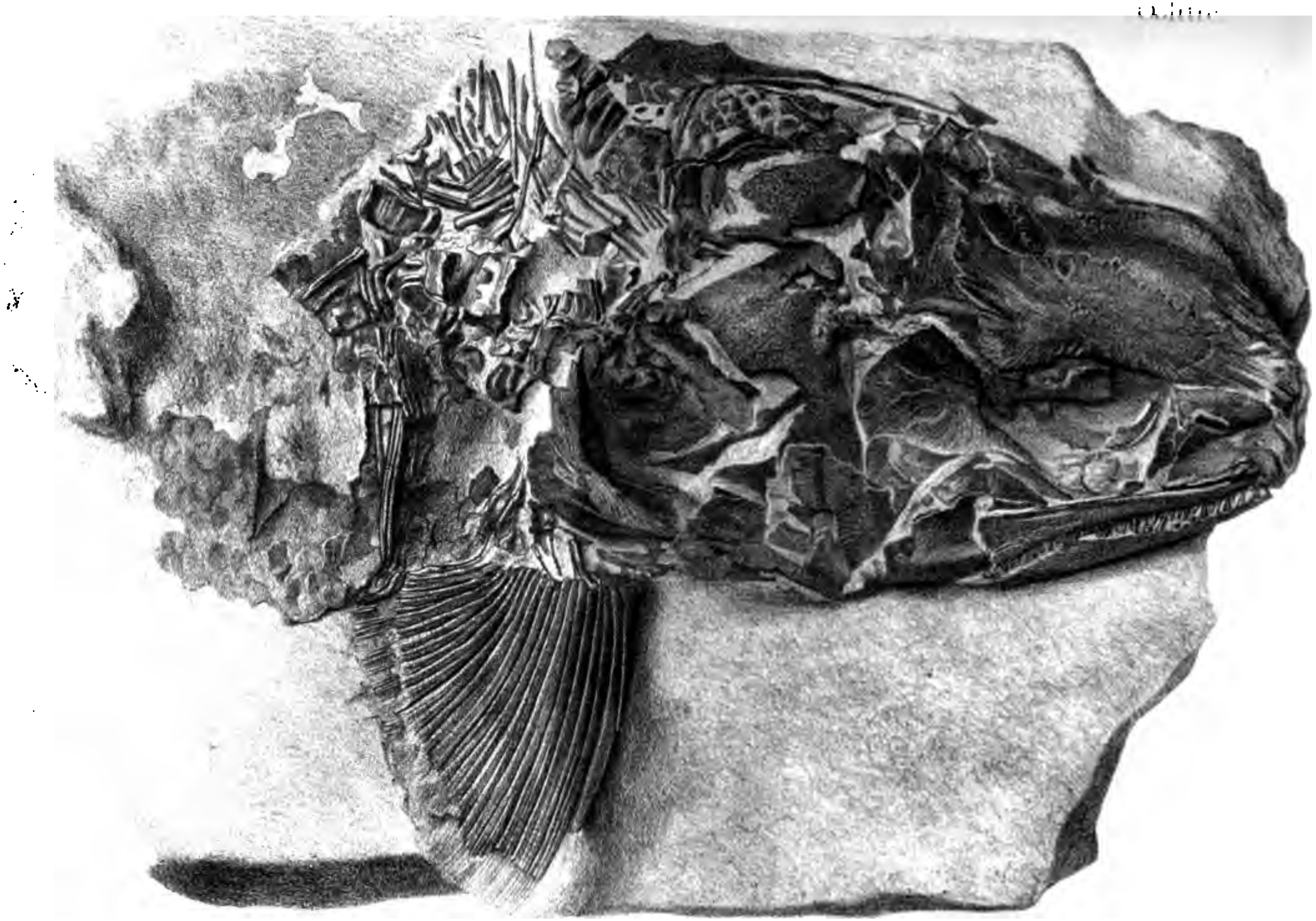
PACHYCORMUS LATIPENNIS.

[Genus PACHYCORMUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group, tail forked.) Body deep; vertebræ normal; pectoral fins large; dorsal fin opposite the ventral fins; scales thin.]

Pachycormus latipennis. AGASSIZ. Poiss. Foss. vol. 2. pt. 2. p. 114.

In detailing the generic characters of his genus *Pachycormus*, Professor Agassiz remarks that the dorsal fin is situated opposite to the interspace between the ventral and anal fins. This is strictly the case in the genera *Oxygnathus* and *Cosmolepis.* In *Sauropsis* the dorsal fin is opposed to the anal fin. In *Eugnathus* the large dorsal is inserted opposite the ventral fins, and extends backwards as far as a point coincident with the commencement of the anal fin. In *Caturus* the dorsal fin is opposed to the ventral fins, and in *Pachycormus* its position is intermediate between that of the like fin in *Caturus* and *Eugnathus.* The first ray is immediately over the insertion of the ventral fins, and the after part of the fin stretches a short distance over the interspace between these fins and the anal fin. Of the predacious ganoid fishes of the Liassic period, the *Pachycormi* form an important group, well characterized by their short and deep form, and the delicacy of their scales, features which contrast powerfully with the lanceolate shape and solid scales of the associated *Eugnathi.* Professor Agassiz has only described four species in the "Poissons Fossiles," but he notifies by name several other species as worthy of more detailed examination. Of these the subject I have selected for this article is one of the best characterized, although the specimens hitherto brought to light show only the anterior portion of the fish.

Description.—Of three specimens under notice referable to this species, I select for description the only one seen by Professor Agassiz, and which is therefore the type of the species. It comprises the head, a portion of the scapulocoracoid arch, the pectoral fin, and a confused mass of scales and vertebræ. The form of the head varies much in this genus. At Whitby, where the species are more numerous than in any other of our British localities, we find a gradation from the small and pointed form of head of *Pachycormus gracilis* and *acutirostris* to the short and deep head which characterizes *Pachycormus latirostris.* Professor Agassiz considers the species under notice to be most nearly allied to the latter species, an approximation which is hardly borne out by a more strict comparison of the two than he was enabled to institute from the materials he had at his disposal. The head of *Pachycormus latipennis* is deeper and broader, and has the snout more blunt than in any other species. It measures four inches in length by two and a quarter in depth; the breadth across the frontal bones is one inch and a quarter. The lower jaw measures two inches and a half in length from the symphisis to the articulating condyle. It is furnished with numerous conical, incurved teeth, varying in size, the largest being situated on the anterior portion of the jaw. The condyloid process is strong, and articulates with a very broad hypotympanic bone. The upper maxillary bone is more slender than the lower jaw; it is dentigerous, the teeth corresponding with those of the lower jaw opposed to them. The large laniary teeth of the latter probably reciprocated with similar teeth on the premaxillary bone and vomer. The frontal bones are broad and very compact in structure. Their surface is covered with slightly elevated sinuous rugæ interspersed with frequent minute punctures, the former prevaling on the posterior, and the latter on the anterior parts of the head. The opercular bones had a somewhat similar surface character, with the addition of a few distant granulations on the upper portion of the operculum. The coracoid bones are very strong, and coarsely plicated longitudinally. The ascending ramus forms nearly a right angle with the lower horizontal branch, this curvature being more abrupt than in other species of the genus. The pectoral fin is very broad, and its constituent rays are flattened as in the genus *Sauropsis.* It differs from the pectoral fin of *Pachycormus latirostris,* in being much shorter and less pointed at the extremity. It contains more than twenty rays. Of these the first is very strong, and single; the succeeding rays remain single for more than half their extent; they then dichotomize, and show frequent transverse joints. In consequence of the great breadth of the constituent rays the surface of the fin when expanded was very large, a character happily seized upon by Professor Agassiz for the specific definition. The



vertebræ, as seen in another specimen, were osseous, the neurapophyses short and slender, and the interneural spines continued over the region anterior to the dorsal fin. In these respects the genus greatly resembles *Caturus*, except that in the latter the vertebral appendages are more robust. The scales are exceedingly thin and overlaid with a very delicate coat of enamel finely sculptured in concentric rings. The free margins were more or less curvilinear, resembling in this respect the scales of *Caturus* and *Leptolepis*.

Locality.—All the specimens of this species hitherto found are from the lias of Lyme Regis.

EXPLANATION OF PLATE.

Pachycormus latipennis, size of nature.

P. DE M. GREY EGERTON.

February 1857.

BRITISH FOSSILS.

DECADE IX. PLATE IV.

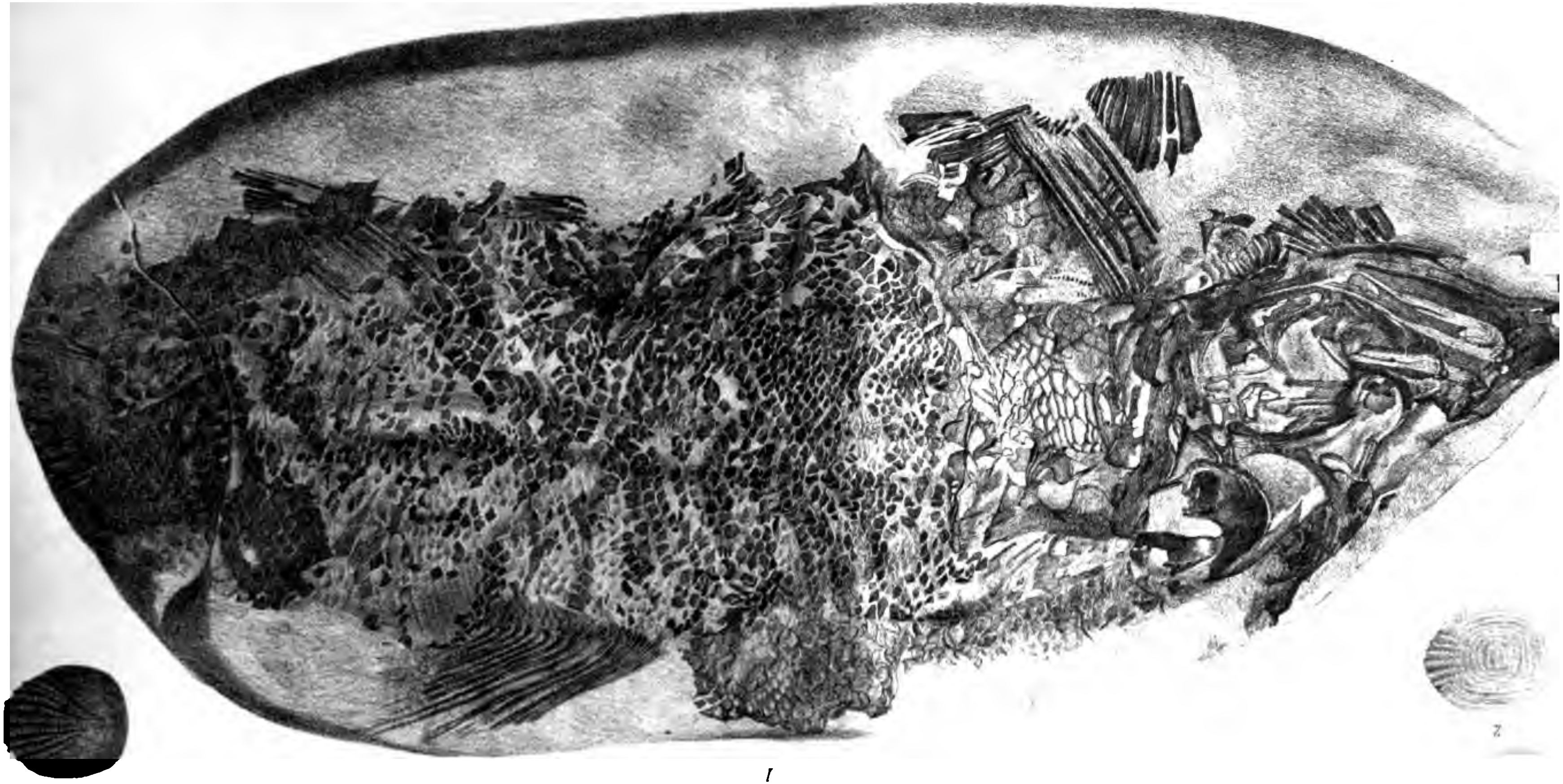
ENDACTIS. GEN. NOV.

[Genus ENDACTIS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 1st Group, tail forked.) Head small and pointed; dorsal fin opposite the ventral fins; anal fin approximated to the ventral fins; base of the tail deep; scales minute, curvilinear, ornamented with raised surface markings.]

SPECIES UNICA. *Endactis Agassizi.*

The subject of the following description is the last fossil fish named by Professor Agassiz before his departure for the United States. I had incorporated it in my cabinet as a new species of *Pachycormus,* but his discriminating eye detected evidences of generic discrepancy which induced him to make it the type of a new genus, which he called *Endactis* from the peculiar character of the scales. It certainly is very nearly allied to the *Pachycormi* in general figure, and in the arrangement of the fins; the most evident distinctions being the larger size of the dorsal fin, the greater thickness of the caudal pedicle and the surface ornament of the scales. It is, perhaps, hazardous to trust to characters so slight, and to the evidence of a single specimen, and that an imperfect one for generic isolation; the more so when we find some of these characters variable and considered as of only specific value in the several species of *Pachycormus* with which we are acquainted. A very important element for deciding the question is unfortunately deficient, namely, the caudal fin. One of the most striking and constant peculiarities of the genus *Pachycormus* is a very large and deeply cleft caudal fin springing from a narrow pedicle, caused by the rapid contraction of the dimensions of the after part of the trunk. This contraction is much less rapid in *Endactis,* as far as the specimen shows, and I am inclined for this reason to believe that future discoveries will reveal a form of caudal fin which will substantiate this as a generic type. Should it prove otherwise, the genus must lapse, but there is no doubt whatever but that the species is distinct from all the *Pachycormi* hitherto discovered.

Description.—The species of *Pachycormus* to which *Endactis* has the nearest resemblance is *Pachycormus curtus*, from the lias of Whitby. The figure given of this species in the "Poissons Fossiles" represents a fish nine inches in length by three inches in depth. The specimen under description is also nine inches in length, but was probably an inch longer when perfect; the depth is only two inches and three quarters. The diameter of the caudal pedicle at a corresponding point in the two specimens is one inch in *Pachycormus curtus* and two inches in *Endactis*. The dorsal fin in the latter is longer and the rays thicker, and the ventral and anal fins are more approximated. Compared with *Pachycormus gracilis*, the body is shorter and the head comparatively smaller. It has no resemblance to any species of *Pachycormus* found associated with it in the Lyme Regis beds. The bones of the head are much crushed, and the operculum is thrown upwards from its position; the latter disturbance makes the head appear larger than it is in reality. It is in fact small for the size of the fish. In form it approaches that of an isosceles triangle, the lines of the forehead and lower jaw being very slightly curved, the snout forming the apex of the figure. The mouth is large, the lower jaw measuring an inch and a half in length. The teeth are wanting. The branchiostegous rays are numerous. Judging from what remains of the pectoral fin, it probably corresponded in size and structure with the analogous organ of *Pachycormus*. The dorsal fin is situated six inches from the snout, and is immediately over the insertions of the ventral fins. It contains at least twenty rays. Of these the four or five anterior ones are single, and increase consecutively in length. They are, however, true rays, carried upon interneural spines, and not fulcral scales. The principal fin rays are transversely jointed at rather distant intervals. The ventral fins are small and indistinct. The anal fin commences one inch and a half behind the attachment of the ventral fins. The interhæmal spines supporting the anterior rays of this fin are very strong. The fin rays are thicker than in any of the *Pachycormi*. The number cannot be discerned, but those that remain correspond in character with the dorsal fin rays. The scales are very numerous. In the neighbourhood of the scapular arch they are rhomboidal, with the posterior angles slightly rounded. In the afterpart of the fish they become curvilinear. They are invested with a thin layer of enamel, on the surface of which an elegant pattern is produced



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by a series of fine diverging rays rising in relief and radiating outwards towards the posterior margin of each scale. A somewhat similar ornament is seen in some species of *Eugnathus*, but no instance has occurred of its presence in any species of *Pachycormus*. Professor Agassiz gave no specific name to this specimen; I therefore dedicate it to him in grateful remembrance of the last of the many happy days it was my good fortune to enjoy in his society.

Locality.—Lias of Lyme Regis, Dorset.

EXPLANATION OF PLATE.

Fig. 1. *Endactis Agassizi*, size of nature.
Figs. 2 and 3. Scales magnified, outer view.

P. DE M. GREY EGERTON.

February 1857.

BRITISH FOSSILS.

DECADE IX. PLATE V.

CENTROLEPIS. GEN. NOV.

[Genus CENTROLEPIS (*κεντρον, calcar; λεπις, squama*). EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci.) Head large; teeth conical; body short; pectoral and anal fins very broad; scales rhomboidal, rugose, with strong spurs on the posterior margin.]

SPECIES UNICA. *Centrolepis asper.* Poiss. Foss. vol. 2. p. 304.

Walking, many years ago, with Lord Enniskillen, on the beach under Black Ven, to the eastward of Lyme Regis, we met a well-known character, by name Jonas, who had just split open a lias nodule which contained a fossil fish. The specimen changed ownership for a few shillings, and from that day I have in vain searched for another fragment to elucidate the affinities of this most singular fish. The family to which it appertained was for some years doubtful. Professor Agassiz, who examined it more than once, was inclined to refer it to the Lepidoidei. More recently, by delicate manipulation, the form of the jaws and characters of the teeth have been discovered, and they unquestionably betoken its affinity to the Sauroidei.

Description.—The distorted position of the fish, and the deficiency of the dorsal portion, render the restoration of the actual proportions a matter of conjecture. The head is large, and the mouth especially so; the body short, and the pectoral and anal fins unusually broad. It is fair to presume, from these features, that the depth of the fish was considerable, and the dorsal fin large. By restoring the head to its natural position, the length of the fish from the nose to the base of the tail is ascertained to be seven inches. Of this dimension the head occupies nearly three inches. The cranial bones are dense, and are ornamented externally with a raised pattern, varying from a granular to a ridge and furrow figure. On the opercular flap the pattern is less prominent, and is associated with what appear to be lines of successive growth, corresponding with the existing outlines of the constituent plates. The mouth measures two inches in length. The teeth are numerous, sharp, and conical; the intervals between the larger ones being beset with smaller ones. No fish of the Lepidoid family has the dental apparatus similarly constituted. The pectoral fins are composed of numerous broad flattened rays. They have frequent transverse joints, and are remarkable for having their surface invested with a corrugated layer of ganoine, corresponding in character with that covering the head bones and scales. This character is common to all the fins. The only similar instance I am acquainted with occurs in the genus *Platysomus*. The first pectoral ray is fringed with scales on its anterior border. The position of the ventral fins is seen about midway between the pectoral and anal fins; the fins themselves are defective. The space between the pectorals and the anal is so confined that the ventral fins were probably of small dimensions. The anal fin is very large, and the rays composing it unusually long. The first ray has fulcral scales and a fringed margin; the subsequent rays are flattened, expanded, and transversely jointed at short intervals; in number they cannot have been fewer than thirty. A few rays of each lobe of the tail are preserved; the multiplication of the transverse articulations is the most striking peculiarity they present. A single broad scale occurs at the base of the lower caudal lobe, but beyond this no fulcral scales seem to have existed in this region. The scales are unlike any I have elsewhere met with; they are rhomboidal, of medium size, and extremely solid. The exposed surface is covered with coarse rugæ, arranged, not, as is commonly the case, in the longitudinal direction, from the anterior to the posterior margin of the scales, but transversely. The free edges of the scales are armed with strong spurs. On the under surface the scales are smooth, and destitute of the midrib so common in the generality of the Sauroid genera. The substance of the scales is so thick that the strong articulating processes of the upper margins are formed out of the uniform thickness of the scales themselves, the extra material provided by the midrib not being requisite. I am not without hopes that the publicity given to what is already known respecting this genus may be the means of bringing to light other specimens, to complete the anatomical details of this most interesting form.

Locality.—Lias of Lyme Regis.

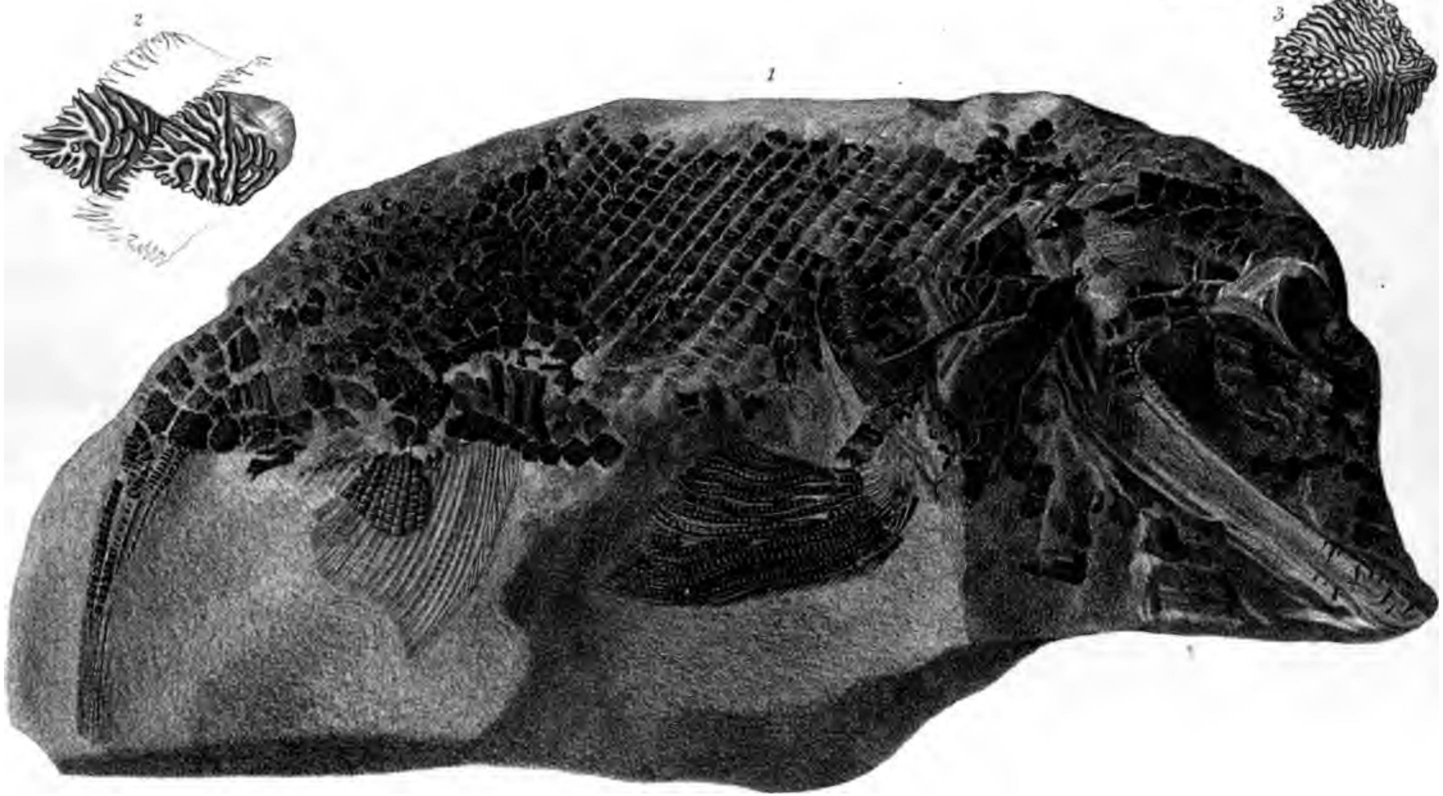
Explanation of Plate.

Fig. 1. *Centrolepis asper*, size of nature.
Fig. 2. Scales, magnified.
Fig. 3. Caudal scale, magnified.

P. de M. Grey Egerton.

February 1857.

CENTROLEPIS
Oolite



CENTROLEPIS ASPER. *Egerton*.

BRITISH FOSSILS.

DECADE IX. PLATE VI.

NOTHOSOMUS. GEN. NOV.

[Genus NOTHOSOMUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2nd Group, body elongated, more or less fusiform.) **Fins small, with fulcra on the first rays. Caudal fin forked. Scales smooth; four rows of broad scales on the flanks.**]

Nothosomus octostychius. AGASSIZ. Poiss. Foss. vol. 2, page 292.

The genus *Nothosomus* is notified in the "Recherches sur les Poissons Fossiles" of Agassiz in the following terms :—"After the genus *Ophiopsis* must be placed a new generic type, which I have distinguished by the name *Nothosomus*, and which is characterized by a long dorsal fin and scales higher than broad." The specimen from which the genus was established was found in the Lias at Street, and presented to me by Mr. Hawkins. It only shows the posterior half of the fish, but as it is the type of the genus, and so far as I am aware the only example of it which has yet been found, it is worthy of being described, the more so that in consequence of the brief notice of Professor Agassiz, it has been quoted by other authors, and is included in all the catalogues of liassic fossils.

Description.—The specimen is broken off immediately in front of the dorsal fin, and the anterior portion is wanting. What remains is, however, in a good state of preservation, and exhibits the dorsal, ventral, anal, and caudal fins, together with the scales of the right flank seen from within. A few impressions of the outer surface of the scales are seen in the anterior part of the specimen. The dorsal fin is situated a little in advance of a perpendicular line extended from the attachment of the ventral fins; the anal fin is inserted about midway between the ventrals and the base of the tail. The interspace between the first ray of the dorsal fin and the upper lobe of the caudal fin measures two inches and a half, and from the ventral fin to the lower lobe of the tail two inches and one tenth. The depth of the trunk from the dorsal fin to the ventral fins is one inch and three quarters; from this point to the spring of the caudal fin, where the diameter is half an inch, the contraction is very regular. In these details *Nothosomus* bears a close resemblance to *Pholidophorus*, and should the positions of the fins in relation to the anterior parts correspond, the general form of the fish would come very near that of one of the shorter and deeper species of that genus. There is also an approximation in the character and mechanism of the scales, and I am therefore inclined to place the genus next to *Pholidophorus*, rather than after *Ophiopsis*, as suggested by Professor Agassiz. The locomotive organs differ essentially from both these genera. In advance of the dorsal fin are five strong fulcral scales, and the first true fin ray has a fringe of short spines along the anterior border. The true rays are six or seven in number, curving backward from their insertions. They are stronger than the fin rays of *Pholidophorus*, and differ also in having the transverse articulations more numerous, and continued nearly to the base of the component rays. The distal extremities are finely fimbriated. The ventral fin contains six rays, more slender than those of the dorsal fin. The anterior one is similarly fringed. The anal fin is composed of twelve rays at least, but they are inserted so closely together, that the exact number cannot be ascertained. The anterior ray is bordered in unison with the corresponding member of the dorsal and ventral fins. The component rays are extremely slender and delicately fimbriated in their distal parts. All the fins, although small with reference to the size of the fish, are comparatively larger than the corresponding organs of *Pholidophorus*; they differ also materially in having bordered margins, and being transversely subdivided to a much greater extent. The caudal fin is deeply forked. The upper lobe contains sixteen rays; the lower one is composed of a like number. Both upper and lower margins are fringed, and a few strong fulcral scales occur at the base of each. The body scales extend rather further on the upper lobe than on the lower. The styles supporting the rays are short and slender, and of equal length in each lobe; in the tail of *Pholidophorus*, the styles of the upper lobe are very considerably longer than those of the lower lobe. The fin rays are stronger in the upper lobe than in the lower. The transverse articulations occur at shorter intervals than in the tail rays of *Pholidophorus;* in the lower lobe the divisions of the ossicles are so nearly coincident that they form continuous elevated lines sweeping across the fin, while in *Pholidophorus* and the allied genera, the articulations of one ray generally impinge between the articulations of the adjoining ray. The result of this arrangement, combined with the frequency of the sub-divisions of the rays of this and the other fins, would be to afford a greater amount of

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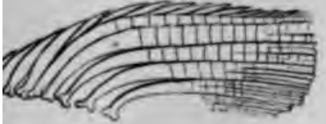

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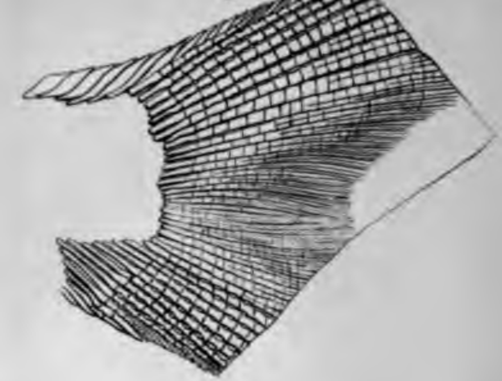

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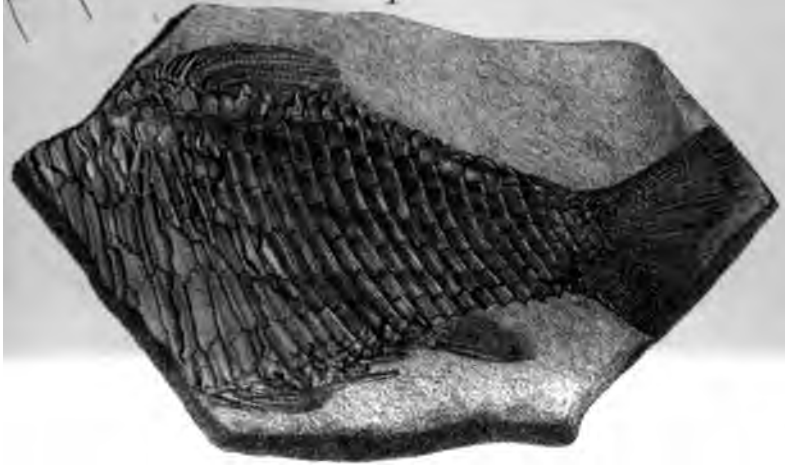

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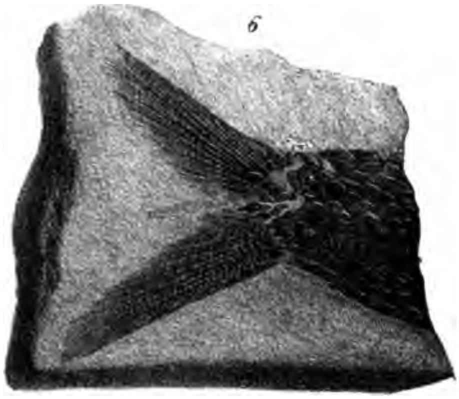

NOTHOSOMUS OCTOSTYCHIUS. Agassiz

lateral flexure in the organs of locomotion in *Nothosomus*, while the necessary support was provided for by the fulcral scales and strengthened borders of the anterior rays. The dorso-ventral series contain eight scales, slightly inclined backwards. The mucous duct pierces the third row from below, this being the position of the largest scales; the row next below it being the next also in size. These and the two rows above the lateral line are considerably larger than those above and below, until near the region of the tail, where all the scales are nearly uniform in size. The scales are thick, compact, and highly lustrous. The outer surface is smooth, and the free margins entire. The inner surface is provided with a broad perpendicular band, occupying the centre of the scales on the flanks, but extending over the entire inner area of the caudal scales. Each band terminates above in a strong pointed process, which locks into a corresponding depression on the lower margin of the scale next above it. Receding towards the tail, these processes become gradually more and more obtuse, until they disappear altogether, and the few most distal scales are united by apposition of the broad margins of the bands. In *Pholidophorus* and the allied genera the scales covering the centre of the flanks are commonly larger than those on the upper and lower margins of the body; but there is always a more or less graduated passage from the one form to the other, by the interposition of scales of intermediate dimensions, even in *Pholidophorus pachysomus*, where the extremes are most exaggerated. The details above given show that in *Nothosomus*, the flanks are protected by four rows of large scutiform scales, succeeded above and below by small scales, the transition from the one form to the other being abrupt. In this respect *Nothosomus* has some resemblance to the sauroid genera *Aspidorhynchus* and *Belonostomus*, but in all other respects it appears to be a legitimate member of the Lepidoid family.

Locality.—The Lias of Street, Gloucestershire.

Explanation of Plate.

Fig. 1. *Nothosomus octostychius*, size of nature.
Fig. 2. Dorsal fin, magnified.
Fig. 3. Ventral fin, magnified.
Fig. 4. Anal fin, magnified.
Fig. 5. Caudal fin, magnified.
Fig. 6. Tail of *Pholidophorus*, magnified.

P. de M. Grey Egerton.

February 1857.

BRITISH FOSSILS.

DECADE IX. PLATE VII. FIG. 1.

PLEUROPHOLIS. GEN. NOV.

[Genus PLEUROPHOLIS. πλευρα, the side; φολις, a scute. EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Lepidostei. Sub-family Lepidostei homocerci. 2nd Group, body elongated, more or less fusiform.) Caudal fin forked; dorsal fin opposite the anal fin; anal fin extended; head small; body slender; scales of the flanks arranged in a single series.]

Pleuropholis attenuatus. MORRIS. Cat. Brit. Foss., 1854.

I propose the generic designation *Pleuropholis* for a small group of fishes of diminutive size and limited geological range, but possessing characters singularly well defined and very distinct from those of any genus of fossil fishes hitherto described. In the form of the head, the position of the mouth, and general outline of the body, they somewhat resemble a small *Thrissops* or *Leptolepis.* The arrangement of the fins also corresponds to some extent with that of those organs in the former genus. The characters of the tail resemble those of *Ophiopsis.* The dermal peculiarities, however, are so remarkable that they forbid the association of *Pleuropholis* with any known genus. If we except the isolated family of the *Acanthodei,* the multiplication of the scales in the dorso-ventral series is greatest in the genera *Pachycormus, Endactis,* and *Cosmolepis.* In the latter we find not less than sixty scales in each series on the anterior and middle regions of the trunk. In *Nothosomus* the number is reduced to eight, and in the sauroid genus *Aspidorhynchus* the flanks are protected by large scutes, the dorso-ventral series being completed above and below by a few scales of much smaller dimensions. These characters are subject to occasional variations in the latter genus, and the single scutes are sometimes replaced by two or three scales. In *Pleuropholis* the dorso-ventral series are also composed of a single row of scutes, completed above and below by a few small scales, the latter being more numerous in the caudal region. In this respect it resembles the cretaceous genus *Priono-*

lepis. I am cognizant of several species, probably referable to this genus, all of which will be noticed in the sequel.

Description.—The beautiful little fish which I have selected as the type of the genus was found by Mr. Bristow in the Middle Purbeck beds at Apsel Lane, north of Sutton Mandeville. It measures two inches in length from the nose to the extremity of the tail, by three-tenths of an inch in depth. The latter measurement is taken at a point midway between the pectoral and anal fins, from which point the body tapers symmetrically to the tail. The head measures four-tenths of an inch in length. The mouth is small and opens upwards, as in *Thrissops* and *Leptolepis.* The relative size and position of the orbit correspond also with these genera. The opercular bones are of moderate size and smooth exterior. The rays of the pectoral fin are strong in relation to the size of the fish. Their number cannot be ascertained. The ventral fins are small, and situated midway between the pectoral and anal fins. The dorsal fin commences at a point two-thirds of the distance from the nose to the fork of the tail. It contains ten delicate rays, single for half their length, and then bifurcated and transversely articulated. They are preceded by a few elongated fulcral scales. The anal fin is opposed to the dorsal fin. It contains twelve rays, rather distant from each other. They correspond in character with those of the dorsal fin. The anterior ray is bordered, a character probably also common to the dorsal fin. The caudal fin is deeply cleft. The upper lobe is invested with scales at its base, and contains nine principal rays, closely set at their insertion. The lower lobe, is also composed of nine rays, more distant from each other than those of the upper lobe. All the rays have frequent transverse joints, more numerous on the lower than the upper lobe. The borders of both are fringed with fine elongated fulcral scales. The scales are smooth. Those on the back, belly, and tail are small and lozenge-shaped. The remainder of the body is covered with a single row of high, narrow scutes, inclining backwards and downwards in slightly sigmoid curves; each scale has a broad elevated band extending from the apex to the base of the inner surface (fig. 9). It is broader above than below, and terminates upwards in a short process, which connects it with the scale next above it in the series.

Locality.—This, the only specimen I have seen of *Pleuropholis attenuatus,* was found by Mr. Bristow in the Middle Purbeck beds at Apsel Lane, north of Sutton Mandeville.

PLATE VII. Fig. 2.

PLEUROPHOLIS CRASSICAUDUS. SP. NOV.

The specimen figured on the same plate with the above, No. 2, was found some years ago by Mr. W. Brodie in the bed known in the Durdlestone Bay section as the Insect Bed. It is now the property of the Rev. P. B. Brodie, of Rowington. It agrees with the genus *Pleuropholis* in the large size of the lateral scales, and in the extent and position of the anal fin; but differs from the species last described in the more massive proportions of the hinder part of the body, and in the characters of the caudal fin. The specimen measures one inch and three quarters from the nose to the base of the tail, and is three-tenths of an inch in depth. The latter measurement falls short of the actual dimensions of the fish, as the dorsal and ventral portions are wanting, and the larger scales alone remain. The head agrees for the most part with that of *Pleuropholis attenuatus*. The operculum is, perhaps, relatively larger, and the ganoid external layer thicker, characters which are repeated in the squamation. The scales comprised in the principal series are broader, thicker, and straighter, those in the vicinity of the tail are longer and more irregular in form. The position of the anal fin is discernible, but its characters are indistinct. The caudal fin has some strong fulcral scales on its lower margin, and appears to have been much stronger and less furcate than in the other species. A small fish discovered by the late Count Münster in the quarries of lithographic stone at Kelheim has a very close resemblance to this species, but the scales are more delicate and greatly more numerous. The tail is more like that organ in *Pleuropholis attenuatus*. A figure of this species is given on the Plate, No. 3. Professor Agassiz originally named it *Pholidophorus lævissimus;* he subsequently removed it to his new genus *Nothosomus;*[*] but it must now be considered a *Pleuropholis*.

Locality.—*Pleuropholis crassicaudus* is from the Insect bed of the Purbeck strata in Durdlestone Bay, No. 106 of Mr. Austen's table.[†]

PLATE VII. Fig. 4.

PLEUROPHOLIS LONGICAUDUS. SP. NOV.

When engaged in examining materials for describing the several species of fossil fishes from the Purbeck strata published in the Eighth Decade of the Memoirs of the Geological Survey, I found two specimens in the Museum in Jermyn Street, which, although very imperfect, gave evidence of another species of the genus *Pleuropholis*. I have recently received from the Rev. John Austen (whose labours in the Purbeck beds are well known to geologists) three additional specimens of a species of *Pleuropholis* apparently different from that indicated by the specimens in Jermyn Street. Of these, one, and that the most perfect, belongs to Mr. W. Brodie, of Swanage, and was found by him in the bed numbered 69 in Mr Austen's table of the Purbeck strata; a less perfect specimen of a larger individual of the same species was furnished by Mr. Lister, of Langton Purbeck, and the third, a smaller one, is from Mr. Austen's private collection. As the specimens in the Jermyn Street Museum are not sufficiently perfect for detailed description, I may here briefly state that my reason for considering them specifically distinct from the subjects of this and the foregoing description rests upon the character of the large scales covering the flanks of the fish, which, in these specimens, are distinctly serrated on the posterior margin.

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[*] Poiss. Foss., vol. 2, p. 288.

[†] Guide to the Geology of the Isle of Purbeck, by the Rev. J. H. Austen, page 17.

Mr. Brodie's specimen, of which a figure is given in the plate, measures three inches and three tenths from the nose to the extremity of the tail; the head and tail each measure seven tenths of an inch, and the greatest depth of the body is six tenths. These comparative dimensions attest the slender proportions of the fish, and, combined with the small size of the head and the large size of the tail, give evidence of its having been a swift and agile swimmer. The head is narrow, and somewhat pointed at the muzzle, the gape small, and with no traces of teeth discernible. In these respects, and in the relative proportions of its constituent members, it resembles the corresponding parts in the genus *Leptolepis*. The pectoral fins contain at least a dozen rays; the anterior one is armed with a border of long sharp spines; the succeeding three or four rays are very strong; all these have the transverse articulations rather distant. The remainder of the fin is composed of smaller bones, not very distinctly preserved. The ventral fins are small, and situated halfway between the snout and the extremity of the tail fin. The anal fin, commencing a little behind the ventral fins, extended almost to the insertion of the caudal fin. The number of rays constituting this organ cannot be ascertained from any of the specimens. The dorsal fin is small in this species, and situated immediately above the anal fin, a position for this fin very unusual in the members of the Lepidoid family, and very characteristic of the genus *Pleuropholis*. The base of the upper lobe of the caudal fin is covered by an oblique prolongation of the scales of the tail. The upper margin of the fin is roofed with a series of elongated, imbricated scales, similar to those seen in the genus *Ophiopsis*, and common to most of the heterocerque fishes. The rays composing the fin are from twenty to thirty in number, and are long and powerful for the size of the fish. The pedicle of the tail is narrow, allowing great latitude of motion to the propelling organ. The general arrangement of the large scutiform scales investing the flanks of the fish corresponds with that described in the foregoing memoir; and is, in fact, a generic rather than a specific character. The scales on the back and belly are small and lozenge-shaped; these are connected, above and below, with the principal longitudinal series of high and narrow scutiform scales covering the parietes of the thorax and abdomen. Beyond the hinder part of the dorsal fin, the smaller scales encroach more and more on the principal series, and the latter diminish in altitude, until, in the proximity of the tail, all the scales are nearly uniform in size. The outlines of the scales in the principal series are waved in double curvatures, representing a series of parallel sigmoid lines of very graceful appearance, the curves becoming gradually less, until, in the caudal region, the scales are nearly rectilinear. All the scales are invested, on the outer surface, with a thick and shining coat of ganoine, without sculpture, and unbroken at the posterior margin. The under surfaces have broad, slightly elevated bands, occupying the median area of each scale (fig. 9). The connexion with the lozenge-shaped scales of the back and belly is provided for by a small process at the upper and a slight depression at the lower extremities of these bands.

Locality.—The specimen belonging to Mr. Lister is from near the bottom of the Downs vein of the Purbeck section, which, as I am informed by Mr. Austen, corresponds with the bed No. 69 in his tabular arrangement. Mr. Brodie's specimen is from the same region of the section, and Mr. Austen's is from a thin shale subordinate to bed 48 of his economic table, which corresponds with No. 69 of the Durdlestone Bay section.

PLEUROPHOLIS SERRATUS. SP. NOV.

PLATE VII. Fig. 5—9.

I have recently ascertained that the specimens in the Museum of Practical Geology indicating another species of *Pleuropholis*, to which I alluded in the description of *Pleuropholis longicaudus*, were derived from the Purbeck strata at Hartwell, near Aylesbury. Through the kindness of Dr. Lee, who has obtained a large number of specimens from the same locality, and who most liberally forwarded them to London for my inspection, I am enabled to complete the characters of a fifth species of this genus, which I have named *Pleuropholis serratus*. The specimens are for the most part so fragmentary that I have found it necessary to compile the specific characters from the examination of several individuals. The most perfect specimen (the only one indeed which conveys the form of the fish) is represented in the accompanying Plate, Fig. 5. The head and tail are both imperfect, and the body is a mere impression, the counterpart of which has, unfortunately, not been preserved. This *Pleuropholis* resembles the other members of the genus in the arrangement of the scales and the disposition of the natatory organs. It differs in its more massive proportions, and in having the posterior edges of the scales serrated. The body is short and deep, compared with the other species resembling in general outline the *Pholidophori*. The dorsal line is nearly straight, the ventral line rounded. The head as seen in the specimen figured No. 7 is small. The mouth opens upwards, and appears to be edentulous. In this character, and in the position of the orbits and form of the opercular flap, it is so like the head of a *Leptolepis*, that apart from other evidence it might be plausibly assigned to that genus. The pectoral fins seen in the same specimen are of small size, containing about ten rays. The ventral fins are deficient in all the specimens; the point of attachment, however, of these organs is seen, in Fig. 5 to have been nearly medial. The dorsal and anal fins, as in the other species of the genus, are opposite to each other, and very similar in form and size. The base of the tail is broad, and the scales do not extend so far on the upper lobe as in *Pleuropholis attenuatus* and *longicaudus*. The dorso-ventral series of scales are about forty in number; of these the first thirty are composed of large scutes, with a few small lozenge-shaped scales above and below. In the ten posterior rows, the scales are more uniform in size. The most appreciable distinctive character of this species is found in the serrated margin of the scales. This is more or less seen in all the specimens I have examined, but generally in the impression of the scales; the scales themselves being in so brittle a condition that they are never well preserved. The specimen I have selected to show the dermal characters is figured No. 6. on the plate. Figs. 8 and 9, show the outer surface of the scale *a*, and the inner surface of the scale *b*, enlarged.

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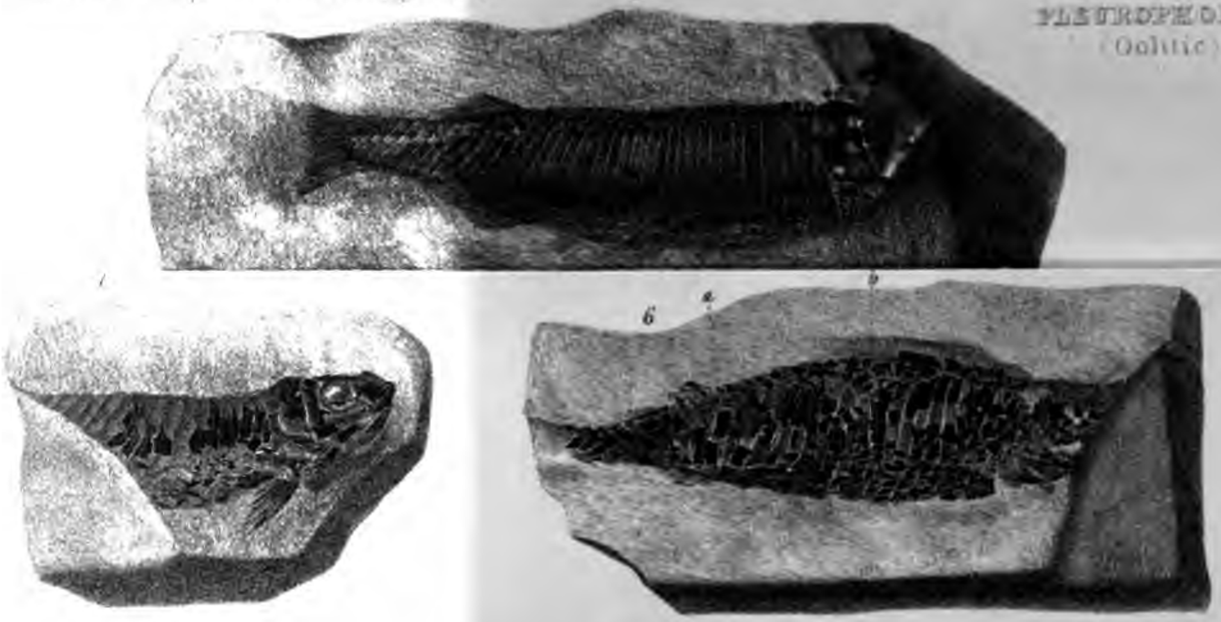
PLEUROPHOLIS.

(Oolitic)



1 PLEUROPHOLIS ATTENUATUS. *Egerton.*
2 PLEUROPHOLIS CRASSICAUDUS. *Egerton.*
3 PLEUROPHOLIS LAEVISSIMUS. *Agassiz.*
4 PLEUROPHOLIS LONGICAUDUS. *Egerton.*
5.6.7 PLEUROPHOLIS SERRATUS. *Egerton.*
8.9 SCALES *a b magnified.*

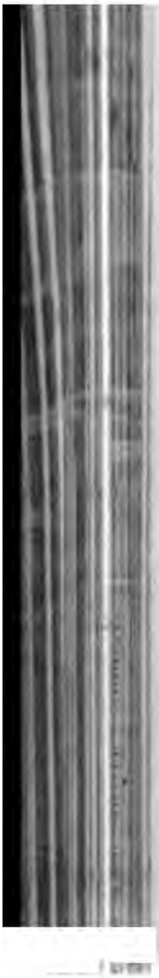
Locality.—All the specimens are from the Purbeck strata of Hartwell, near Aylesbury.

Explanation of Plate.

Fig. 1. *Pleuropholis attenuatus*, magnified.
Fig. 2. *P. crassicaudus*, size of nature.
Fig. 3. *P. lævissimus*, size of nature.
Fig. 4. *P. longicaudus*, size of nature.
Fig. 5. *P. serratus*, size of nature.
Fig. 6. *P. serratus*, size of nature.
Fig. 7. *P. serratus*, size of nature.
Fig. 8. Scale *a*, magnified.
Fig. 9. Scale *b*, magnified.

P. de M. Grey Egerton.

February 1857.



BRITISH FOSSILS.

DECADE IX. PLATE VIII.

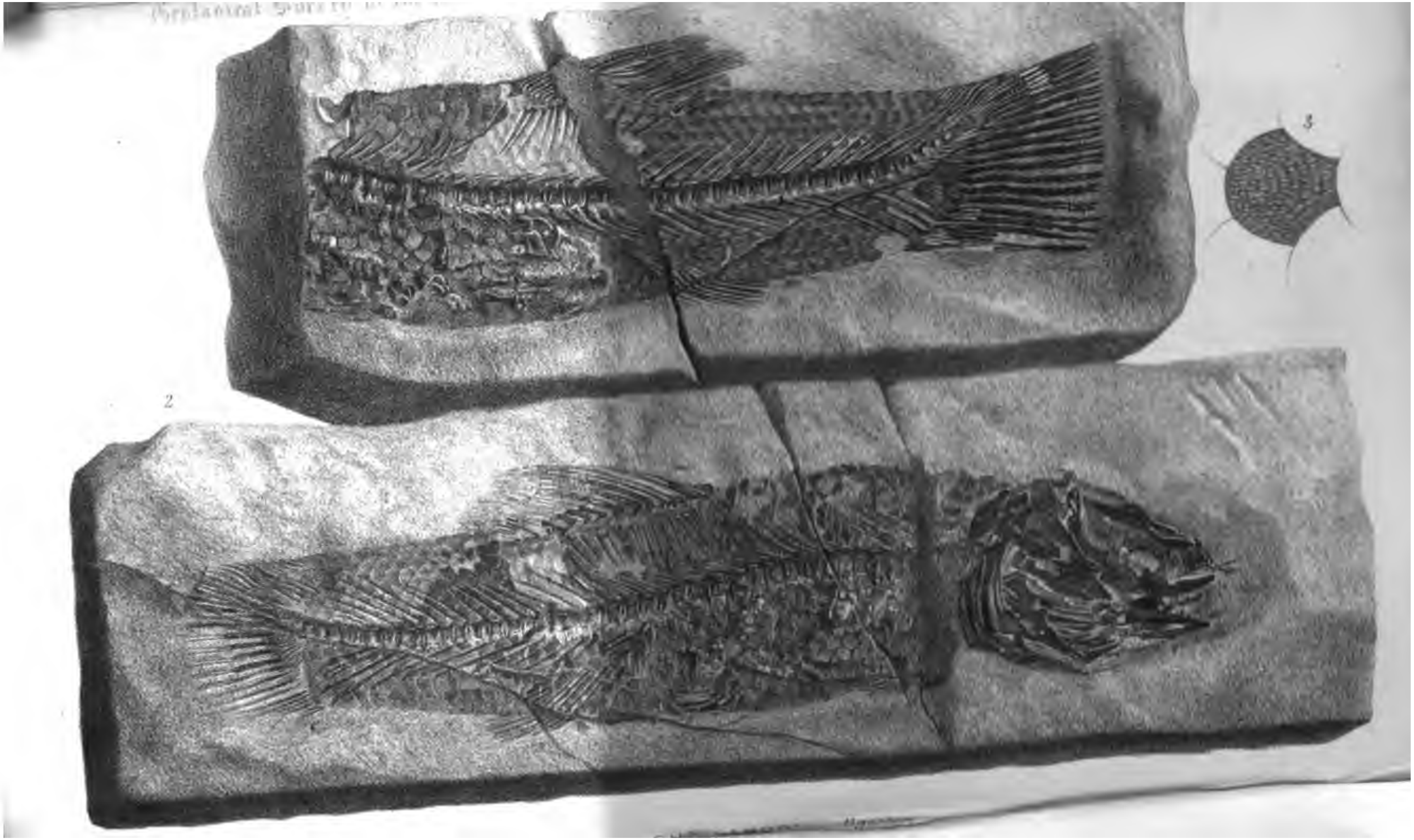
MEGALURUS DAMONI.

[Genus MEGALURUS. Agassiz. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 2nd Group, tail more or less rounded.) Caudal fin very large and rounded; dorsal fin opposed to the interspace between the ventral and anal fins; head large; jaws furnished with large conical teeth, intermixed with smaller ones. Vertebral centres ossified.]

Megalurus Damoni, Sp. Nov.

This remarkable genus is placed by Professor Agassiz in a small group at the end of the Sauroid family, comprising in addition one fossil genus *Macrosemius*, and the recent genera *Lepidosteus* and *Polypterus*. The characters common to these four genera are the upward tendency of the termination of the vertebral column, and the rounded form of the caudal fin. In other respects they differ widely from each other. M. Pictet, laying greater stress upon the dermal peculiarities, has proposed a new order, "les ganoides cyclifères," for the reception of the fossil ganoids having rounded, imbricated scales. He divides this order into four families; the first comprises the recent *Amia*, and the fossil genera *Notœus* and *Cyclurus;* the second, "les Leptolepides," the genera *Leptolepis, Tharsis, Thrissops, Megalurus, Oligopleurus*, and *Coccolepis;* the third and fourth, "les Celacanthes" and "les Holoptychides," embrace the Cælacanthoid family of Agassiz. This is not the place to discuss at length the validity of the proposed new arrangement. The objections to it are manifold, and until some more satisfactory solution of the admitted incongruities of the old system is propounded the lesser evil will be to abide by the latter, rather than introduce new elements of discord of greater magnitude than those complained of. The ordinal titles proposed by M. Pictet involve a contradiction, for he associates together as "Ganoides cyclifères" several genera, some having and some devoid of the true ganoid character of the scales. Again, in his second order, "les Ganoides rhombifères," he includes *Pachycormus* and *Caturus*, genera in which the rhomboid form of scale becomes nearly obsolete, and the curvilinear character begins to be appreciable. The reasons adduced in favour of the new scheme, from the teeth and other structural details, are still more untenable than those derived from the dermal characters; but the subject is too large to be further pursued in this article. The genus *Megalurus* is unquestionably a member of the Ganoid order as defined by Agassiz, the scales being invested with a coat of enamel, which, although thin, is unmistakeable. I have ascertained that the scales of *Leptolepis* are similarly coated, a fact which is disputed by M. Pictet, and other continental ichthyologists. The large teeth of *Megalurus* designate its position as a genus of the Sauroid family. The structure of the vertebral column and its appendages, with the exception of the caudal portion, resembles that of the corresponding parts in *Caturus*. The distal extremity of the column and the caudal fin are most like those parts in *Macrosemius* and *Lepidosteus*, with some affinities to the Cœlacanthoid family, more especially to the genus *Undina* of Count Münster. The genus *Oligopleurus* of Mr. Thiollière appears to be intermediate in character between *Caturus* and *Megalurus*, and affords an easy transition from the one to the other.

Description.—All the species of this genus hitherto described are from continental localities, their stratigraphical position being limited to the upper region of the Oolitic system. The subject of this article was discovered last year by Mr. Damon in the vicinity of Weymouth. It is intermediate in size between *Megalurus lepidotus* and *Megalurus elongatus* of Agassiz; it differs from the former in having the head comparatively shorter, the body more slender, and the scales more elongated; and from the latter in being a shorter and deeper fish. The specimen measures six inches from the nose to the extremity of the vertebral column, by one inch and a half in depth from the dorsal to the ventral fins. The body diminishes very slightly to the tail, the smallest diameter being one inch and one tenth. The head is one inch and seven-tenths in length, by one inch and two-tenths in depth. The scapulocoracoid bones are strong and smooth, having a thick prominent rib on the inner anterior margin. The vertebral column traverses the centre of the body. It is straight until it nearly reaches the tail, where it has an upward curvature. It contains about fifty biconcave vertebræ. The apophyses are short for the proximal two thirds of the column, but in the distal third they increase consecutively in length to the base of the caudal fin, and thence decrease towards the extremity of the column. The pectoral and ventral fins are small and indistinct. The first ray of the dorsal fin is imme-


2
3

diately over the attachment of the ventral fins. The middle of the fin is coincident with the centre of the dorsal line. It is supported upon seventeen strong interneural spines, and contains a like number of rays. These are entire for some distance from the base; they then bifurcate, and are transversely jointed at small intervals. The anal fin is situated nearer to the ventrals than to the lower lobe of the caudal fin. It is attached to eight ossicles, and is composed of as many rays, agreeing in all respects with those of the dorsal fin, except in being shorter and more slender. There are traces of border scales on the first rays of both. The caudal fin is broad and rounded posteriorly. In form it resembles the tail of the recent *Lepidosteus*. A few fin rays, constituting the upper lobe, spring from the neurapophyses of the sixth, seventh, and eighth vertebræ, reckoning from the caudal extremity of the column. These are single, without bifurcations or transverse joints; the remainder, about twenty in number, are supported by the flattened extremities of the elongated hæmapophyses. They are coarse, with three or four bifurcations and frequent joints. The fin is completed below by a few single rays springing from the hæmapophysis of the fifteenth vertebra. This is the longest of these processes; those behind it decrease in gradation to the extremity of the column. The scales are large, and rounded posteriorly; they differ from the scales of *Megalurus lepidotus* in having the longitudinal diameter greater than the transverse. They are thick, and of a coarse texture, and are covered exteriorly with a thin coat of enamel, ornamented with fine concentric rings. They have no rib or articulating process on the inner surface. In this respect, and in their imbricated arrangement, they very much resemble the scales of a *Cœlacanthus*. This very interesting addition to our list of British fossil fishes I have designated by the specific name of *Megalurus Damoni*.

Locality.—Found by Mr. Damon in the Purbeck strata at Binombe, about three miles north of Weymouth.

EXPLANATION OF PLATE.

Fig. 1. *Megalurus Damoni*, size of nature.
Fig. 2. Counterpart of do., size of nature.
Fig. 3. Scale, magnified.

P. DE M. GREY EGERTON.

February 1857

BRITISH FOSSILS.

DECADE IX. PLATE IX.

MEGALURUS AUSTENI.

[Genus MEGALURUS. AGASSIZ. Sub-kingdom Verebrata. Class Pisces. Order Goniolepidoti. Family Sauroidei. Sub-family Sauroidei homocerci. 2nd Group; tail more or less rounded.) Caudal fin very large and rounded; dorsal fin opposed to the interspace between the ventral and anal fins; head large; jaws furnished with large conical teeth, intermixed with smaller ones; vertebral centres ossified.]

Megalurus Austeni. SP. NOV.

Description.—The discovery of the very perfect specimen described in the preceding article has furnished the clue to the true nature of a group of icthyolites not uncommonly occurring in the quarries of Purbeck stone at Swanage, but for the most part in a very fragmentary condition. Many of these specimens have come under my notice from the collections of Mr. Austen and others, who have turned their attention to the Purbeck fossils; but I have hitherto failed to recognize them as belonging to the rare genus *Megalurus* of Agassiz. The parts most commonly preserved are the vertebral column and some of its spinous appendages, and such specimens have generally been considered as belonging to the *Lepidotus minor*, so common in the Swanage quarries. Last year I obtained a specimen, more perfect than any I had before seen, of this fish, but as the tail, so characteristic of the genus was deficient, I passed it over without a detailed examination, in the hopes that more satisfactory evidence of its generic affinity might be brought to light. While examining the specimen described in the last article, and comparing it with other specimens, I became aware of the affinity between it and the Swanage specimens, a result which subsequent investigation proved to be correct as to general relationship, the species, however, being distinct. The portion of the fish preserved in the specimen comprises about two-thirds of the entire length, the hinder third being deficient. The pectoral, ventral, and dorsal fins are seen in situ, but the anal fin is wanting. The fish, when entire, would probably measure ten or eleven inches in length. The greatest depth is two inches and a half. The head is proportionately smaller than in the other species of *Megalurus*, and the posterior edge of the opercular flap more angular. The dorsal line is nearly straight, while the abdominal line has a considerable downward curvature. These lines are nearly parallel in *Megalurus Damoni*, and in *Megalurus lepidotus* the dorsal line is more curved than the abdominal line. Thirty-five vertebræ are preserved, of strong osseous texture. The length of each is rather greater than the diameter. The peripheral pits are deep and strongly marked, but the size of the intervertebral cavities cannot be ascertained. The processes of the anterior vertebræ are short, thick, and curved, those of the posterior part of the column straight, long, and slender. The scapulocoracoid arch appears to have been slight, and the pectoral fins of moderate size. The component rays are subdivided transversely into a great number of ossicles, a structure which must have given great pliability to the fin. The ventral fins are small, but strengthened by a thick anterior ray to each fin, having considerable curvature at its pelvic extremity. The dorsal fin is situated over the ventral fins, and extends as far backwards as the insertion of the anal fin. The three or four anterior rays are short, strong, and pointed, the succeeding rays are long, dichotomous, and articulated transversely at short intervals. The number of rays composing the fin was not less than seventeen, and these are supported on a like number of interapophyseal ossicles deeply inserted in the integumentary tissues. The position of the anal fin is seen by a slight impression of the anterior rays in the matrix of the specimen, but an unfortunate fracture has removed the fin itself. The scales more nearly resemble those of *Megalurus lepidotus* than those of *Megalurus Damoni;* they are, however, too imperfect to be accurately examined. I have named this species *Megalurus Austeni*, in recognition of the labours of the Rev. John Austen in working out the stratigraphical details of the Purbeck beds.

Locality.—The specimen figured and described was found in a quarry of Purbeck stone in the neighbourhood of Swanage, and is now in my possession.

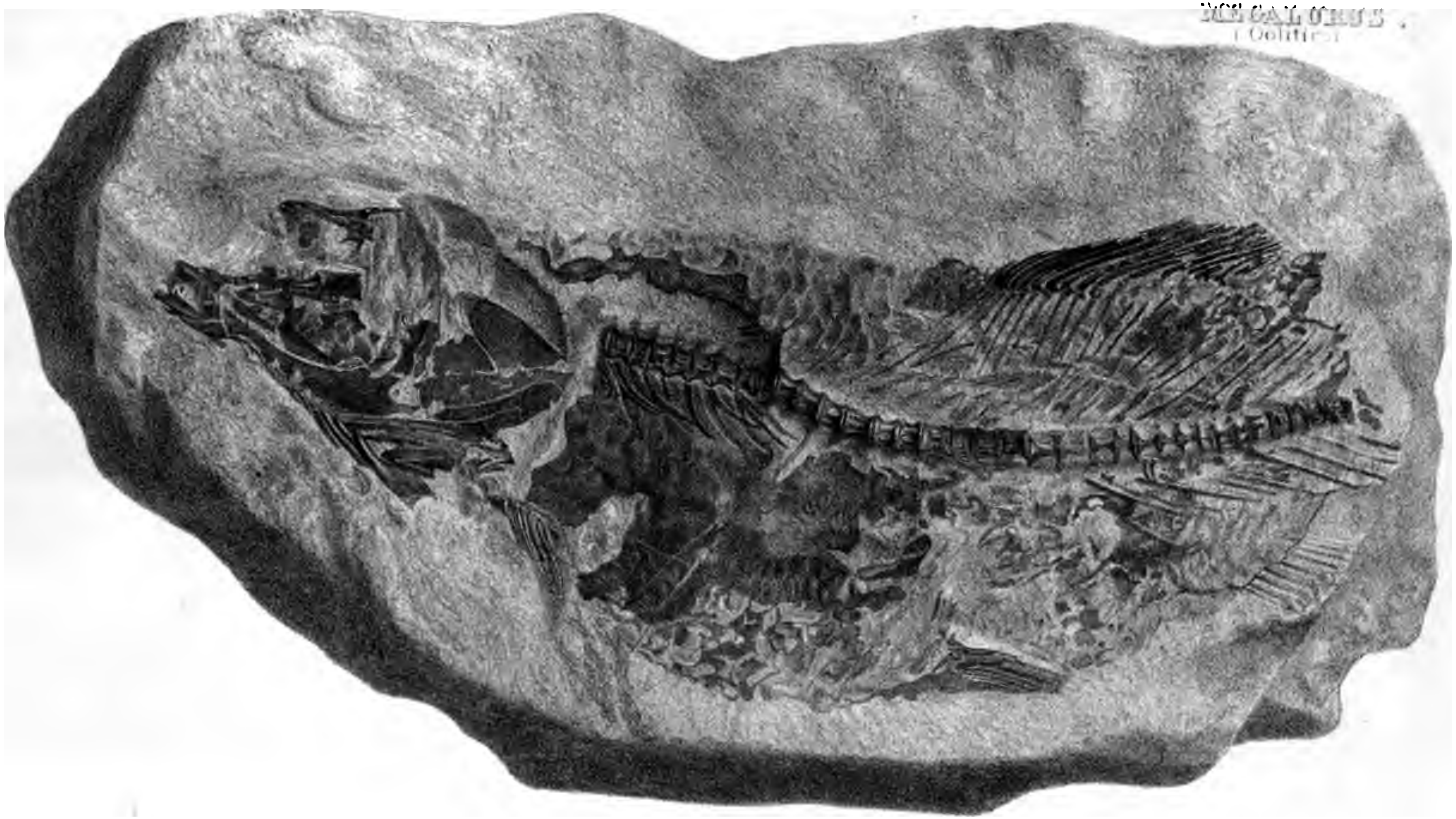
Description of Plate 9.

Fig. 1. *Megalurus Austeni*, size of nature.

P. de M. Grey Egerton.

April 20, 1857.

MEGALURUS.
(Oolite.)



MEGALURUS AUSTENI _ *Egerton*.

BRITISH FOSSILS.

DECADE IX. PLATE X.

MACROPOMA EGERTONI.

[Genus MACROPOMA. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Cælacanthi.) Caudal fin very large, rounded. Two dorsal fins, one over the interspace between the pectoral and ventral fins, the other opposed to the interspace between the ventral and anal fins. The rays armed with marginal spines. Scales enamelled, imbricated, rounded posteriorly, and tuberculate. Teeth large and conical, intermixed with smaller ones. Vomer and palatines dentigerous.]

Macropoma Egertoni. AGASSIZ. Poiss. Foss. vol. 2, part 2, page 186.

At the time when Professor Agassiz was engaged upon his great work on the Fossil Fishes, the materials crowded in upon him in such abundance that he found it impossible to comprise them all in one publication, with any prospect of completing it in reasonable time. He therefore determined to finish his original work in five volumes, and to postpone the descriptions of those species he could not incorporate, to form a series of supplementary monographs. He was only able to issue one of these, that on the fishes of the Old Red Sandstone, before his engagements in the United States put a stop to his ichthyological labours on this side the Atlantic. As there seems to be little chance now of his resuming the subject, it appears to me desirable that some of the most characteristic genera and species which were named by him, but not described, should no longer remain in our catalogues undefined. I have therefore selected a few of the most striking forms for description in this Decade. The genus *Macropoma* is one of the most singular in the whole range of fossil ichthyology. We owe its discovery to the indefatigable zeal and scientific skill of the late Dr. Mantell, who described the only species then known under the name of *Amia Lewesiana.* Professor Agassiz subsequently determined it could not be considered as belonging to that genus, but that it constituted a new generic type, to which he gave the name now adopted. The specific name given by Dr. Mantell ought to have been continued, but a departure from the rigid rule of scientific nomenclature was justifiable in this case for the purpose of perpetuating the name of the talented discoverer of *Macropoma Mantelli*. The remains of this fish are most numerous in the chalk formations of the south of England, and are all referable to one and the same species. The subject of this article constitutes a second species of the genus found in the Gault at Speeton, in Yorkshire. The specimen which is in my possession is unique, and Professor Agassiz did me the honour of naming it after me.

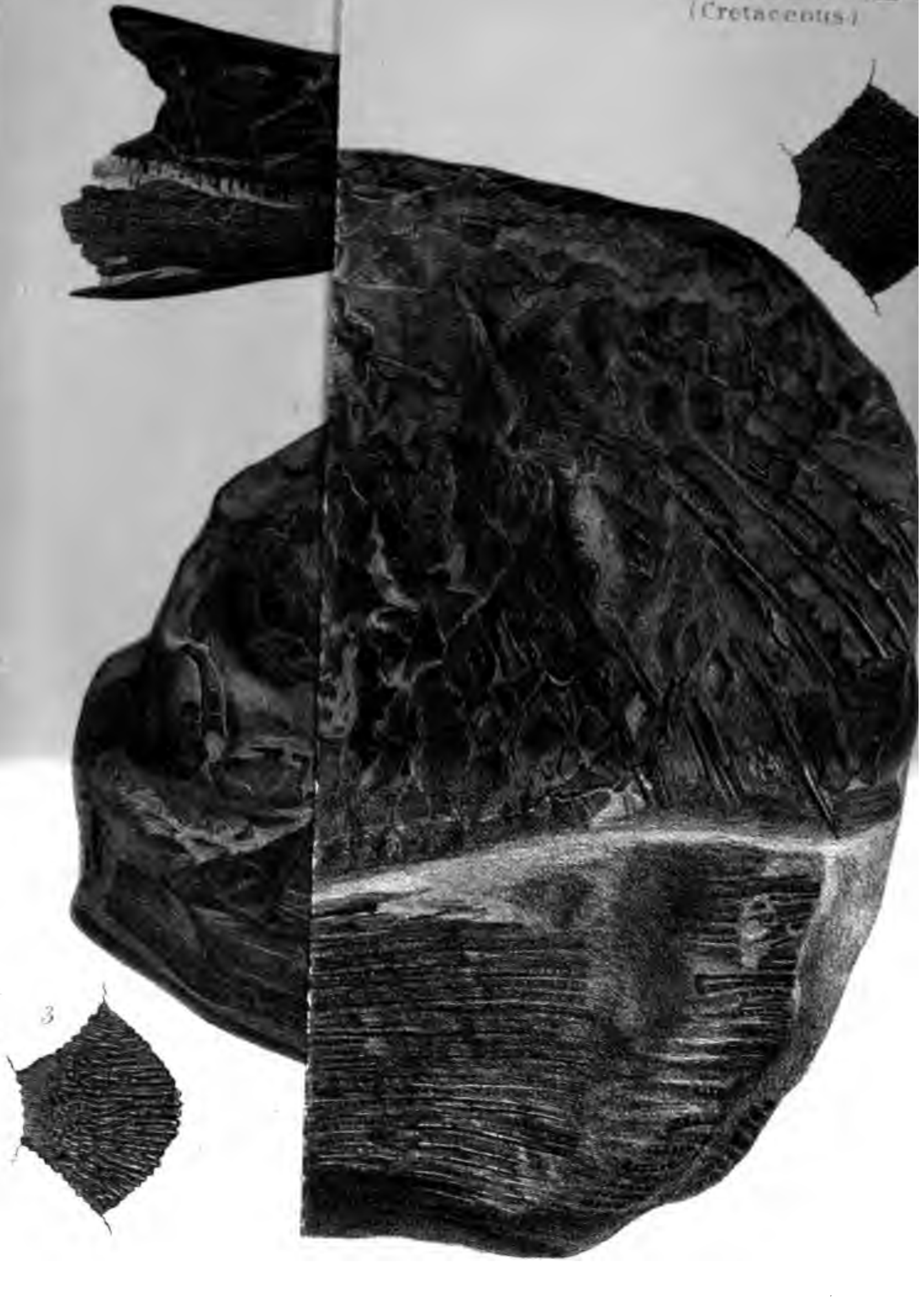
Description.—The reasons assigned by Professor Agassiz for considering this a distinct species in the short allusion he makes to it in the "Poissons Fossiles," are, "the more uniform character of the scales, and differences in the form of the head." These and other specific peculiarities will be treated of in the sequel. The specimen exhibits only the anterior half of the fish; comprising the head, the pectoral fin, and the first few rays of the dorsal fin. It evidences a fish of the largest dimensions attained by the Mantellian species. The head from the snout to the posterior edge of the operculum measures seven inches; the depth at the occiput is five inches and a half, and the breadth across the frontal bones three inches. The inclination of the profile line of the head is very steep from the occiput to the orbit, far more so than in the allied species; the orbit is situated in a more advanced position, and the facial line thence to the snout falls much more rapidly. The opercular apparatus covers a far larger area, and the breadth of the cranium is comparatively greater. The orbit in this species is large, and a portion of the capsule of the eye is preserved. The frontal bones are wide, coarse in texture, and bear a few scattered granules on their exterior surface. The borders of the upper jaw are formed by the superior maxillary bones, which are very broad; they are beset with very numerous sharp pointed teeth, closely arranged and of uniform size. The lower jaws are also very broad, and the space between the rami is closed by a single glossohyal plate, as in *Lophiostomus*, *Arapaima*, and *Amia*. The lines of demarcation between the opercular bones are not discernible, but the entire apparatus is considerably larger than the corresponding parts of *Macropoma Mantelli*. The pectoral fin is of large dimensions. This organ is not mentioned in the description of *Macropoma Mantelli*, nor is it well seen in any of the specimens of that species I have examined. It may or may not, therefore, be a distinctive and specific character. The fin is by no means perfect in my specimen, but it measures four inches and a half in length, by two inches in breadth. The rays are very numerous, and differ from those of the dorsal fin by being dichotom-

Geological Surv

DECADE IX PL.10

MACROPOMA

(Cretaceous)



ized, transversely jointed, and devoid of spines. The base only of the dorsal fin is visible; it is situated three inches from the occiput. The scales are smaller and more uniform in size than those of the other species; they are rounded posteriorly, and are higher than long. The surface ornament is very different; instead of the distinct tubercles so characteristic of that species, it is composed of minute granules united into longitudinal rows, with only a few small tubercles, interspersed occasionally, on some of the larger scales. The characters above detailed fully warrant the specific distinction of this from the species described by Dr. Mantell.

Locality.—Found in the Gault strata at Speeton, in Yorkshire.

Description of Plate.

Fig. 1. *Macropoma Egertoni*, size of nature.
Fig. 2. Maxillary bones of the opposite side.
Figs. 3. Scales, magnified.

P. de M. Grey Egerton.

February 1857.

Note.—Since the above description was written, I have received from Mr. Beckles a specimen of a *Macropoma* found in the quarries of Purbeck stone near Swanage. The specimen is not sufficiently perfect to determine the species; it seems to be a shorter and deeper fish than *Macropoma Mantelli.* It is interesting to know that the genus was in existence previous to the deposition of the cretaceous system.

P. de M. Grey Egerton.

April 20th, 1857.

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OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

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BRITISH FOSSILS.

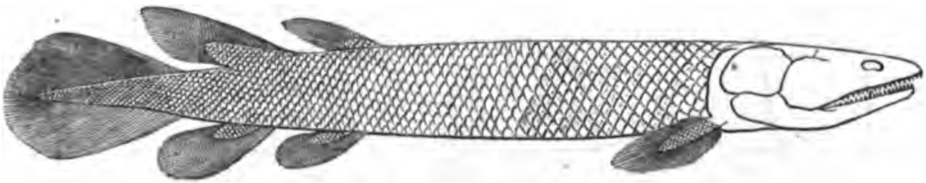
DECADE THE TENTH.

PRELIMINARY ESSAY upon the SYSTEMATIC ARRANGEMENT of the FISHES of the DEVONIAN EPOCH, by THOS. H. HUXLEY, F.R.S., Professor of Natural History, Government School of Mines.

THE endeavour to determine the systematic position of *Glyptolæmus*, a genus of Devonian fishes, first described and figured in Dr. Anderson's interesting work upon "Dura Den,"* and more fully discussed and illustrated in the course of the present Decade, has gradually led me to reconsider the whole question of the classification of the fishes of this epoch and, eventually, to arrive at results which seem to necessitate an important modification of the received arrangement of the great order of Ganoidei.

I propose, in the course of the pages of this preliminary essay, to take the reader through the various steps of the argument which terminates in this conclusion; and, commencing with a brief enumeration of the most important characters of *Glyptolæmus*, I shall proceed to the discussion of the peculiarities of other genera, more or less nearly allied to it, with the view of demonstrating, finally, that *Glyptolæmus* is a tolerably typical member of a large and well defined family of Ganoids, which abounded in the Devonian epoch, but whose members have been less and less numerous in more modern formations, until, at present, its sole representative is the African *Polypterus*.

FIG. 1.



Restoration of *Glyptolæmus*.

Glyptolæmus Kinnairdi (fig. 1, and Plates I. and II.), the only known species of its genus, is a fish with an elongated body, a depressed head, and a conically tapering caudal extremity. The orbits are situated forwards, while the gape extends far back. The frontal bones (fig. 2) are distinct from one another and from the parietals, which last are not shorter than the frontals, and, though in contact throughout the whole length of their inner margins, are perfectly distinct from one another. Three bones, or scales (for they seem to partake as much of the nature of the latter as of the former), a median and two lateral, roof in the occipital region. The middle of the jugular region, or that comprised between the two rami of the mandible upon the under surface of the cranium, is occupied by two large, triangular, squamiform, bones—the *principal jugular plates* (j¹); while the interval left between them and the mandibular rami, on each side, is taken up by a series of smaller, quadrate plates, which increase in size from before backwards—the *lateral jugular plates* (j²). There is no rhomboidal *median jugular plate* interposed between the anterior part of the inner edges of the principal jugular plates. The teeth are of two kinds; smaller, set in a close series along the edges of the jaws; and larger, placed at intervals along the palate, and perhaps along the inner side of the mandible. The larger teeth have grooved bases, and appear to be composed of dendrodentine.*

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* Dura Den; a Monograph of the Yellow Sandstone, and its remarkable Fossil Remains. 1859.

FIG. 2.

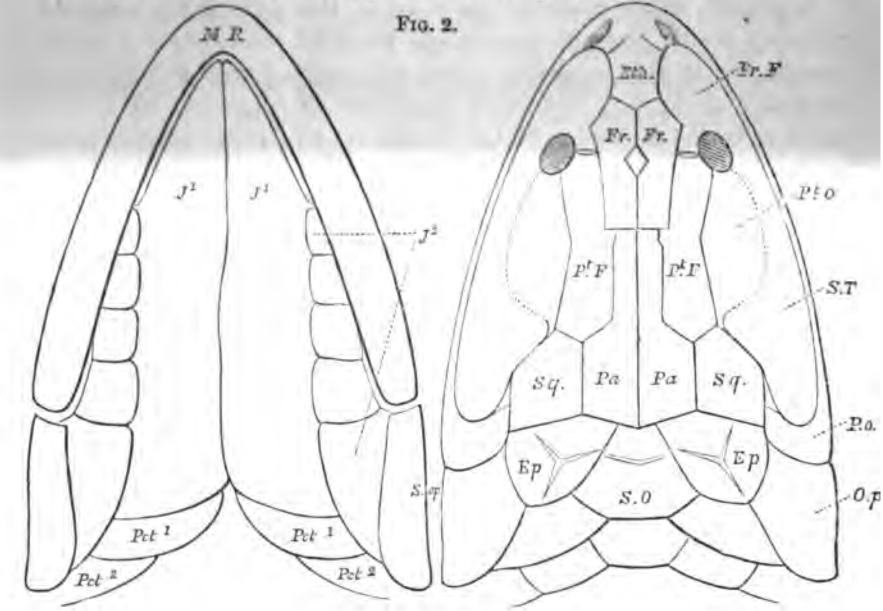

Diagram of the Head of *Glyptolæmus*.—For an explanation of the letters, see p. 40.

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* Prof. Pander applies the term "Dendrodonts" to those fishes the pulp cavities of whose teeth appear branched, in consequence of the folding of their walls; and such folded dentine may be conveniently termed "dendrodentine."

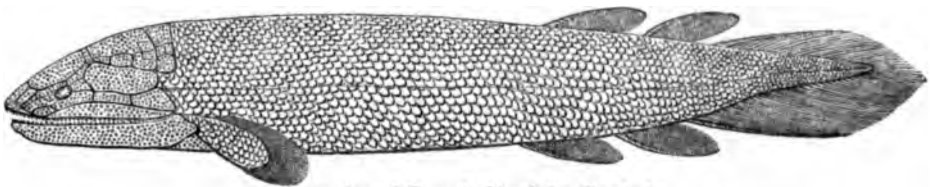
The pectoral arch is covered by two triangular, sculptured, osseous plates (Pct^1, Pct^2), which meet in the middle line below and are superficial to the so-called coracoids. The paired, or pectoral and ventral, fins are lobate; that is, the fin has a central axis, or stem, covered with scales. There are two dorsal fins, placed in the posterior half of the body. The ventral fins are situated under the first dorsal, and are succeeded by a single anal. The caudal fin, whose contour is rhomboidal, is divided into two equal lobes by the prolonged conical termination of the body; in other words, the fish is diphycercal, or truly homocercal.[*]

Every ichthyologist will admit the singularity of this combination of characters, but a careful analysis of the structural peculiarities presented by other fossil fishes of the same age, will show, that, so far from isolating *Glyptolæmus*, they closely unite it with several other genera.

That genus which appears to me to approach it most closely is the *Gyroptychius* of M'Coy, whose structure has received admirable elucidation from Professor Pander in his beautiful monograph "Ueber die Saurodipterinen, Dendrodonten, Glyptolepiden und Cheirolepiden des Devonischen Systems" (1860), to which I may refer those who desire to obtain a more particular acquaintance with the details of its organization.

Here I must content myself with reproducing in a reduced woodcut (fig. 3) Professor Pander's restoration of the fish, which may be compared with the restored woodcut of *Glyptolæmus* (fig. 1), and with the Plates, and with stating that the head, the body, and the fins of *Gyroptychius* might be described in the terms which have just been applied to *Glyptolæmus*. Pander, however, makes no

FIG. 3.



Restoration of *Gyroptychius* (after Pander).

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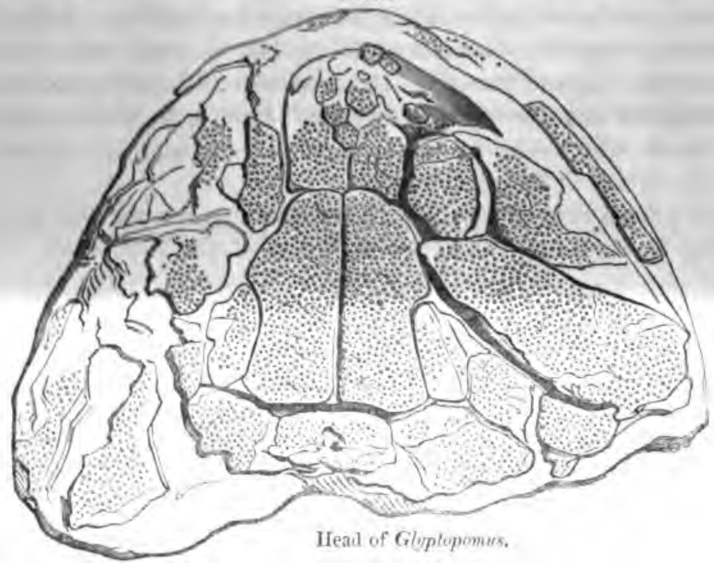
[*] I have endeavoured to show elsewhere (Quarterly Journal of Microscopical Science, Oct. 1858) that the so-called "homocercal" *Teleostei* of the present epoch are in reality excessively heterocercal; but the word "homocercal" is now so generally understood to signify a tail like that of most existing *Teleostei*, that I prefer to employ Prof. M'Coy's term "diphycercal" for truly homocercal tails. See, on this point, Kölliker, "Ueber das Ende der Wirbelsäule der Ganoiden, 1860," and Van Beneden, "Sur le Développement de la Queue des Poissons Plagiostomes," Bull. de l'Acad. Royale Belgique, 1861.

mention of lateral jugular plates; the scales, which are as often oval as rhomboidal, are sculptured in a very different manner from those of *Glyptolæmus*, and, according to Pander, the anterior edges of the median fins are provided with fulcra.

Glyptopomus (Agassiz) is another genus whose close alliance with *Glyptolæmus* is evidenced by the structure of its skull, of which there is a fine specimen in the British Museum. It is very depressed and has two distinct frontal bones, separated anteriorly by a small rhomboidal plate; there are two long and distinct parietals, and three bones, one median and two lateral, behind these, covering the occiput. The orbits are situated far forward, the gape is greatly elongated, there are two principal jugular plates, and the pectoral arch is as in *Glyptolæmus*. A fine specimen in the Museum of Practical Geology shows that some of the teeth, at any rate, were of large size, and longitudinally grooved at their bases.

Fig. 4.



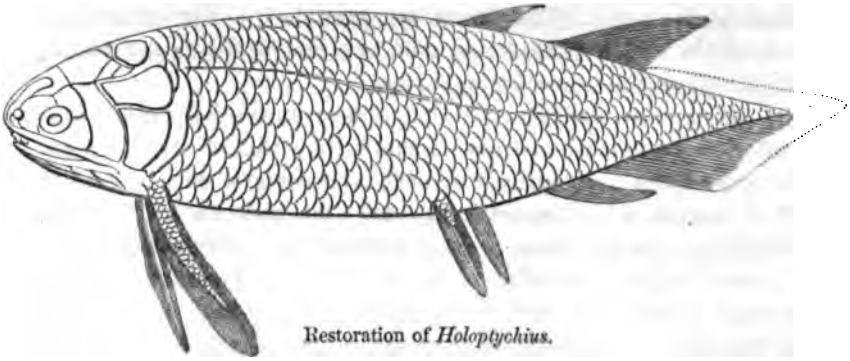
Head of *Glyptopomus*.

Only three specimens of *Glyptopomus* are at present known, and no one of these exhibits either the paired or the median fins; but the close correspondence of the cranial structure of this genus with that exhibited by *Glyptolæmus*, leaves no doubt on my mind that, when discovered, the fins will be found to be similar, in all essential respects, to those of the latter genus (*see* note, p. 46). The sharply rhomboidal scales are thicker in proportion than those of any other Devonian fish, and are pitted upon their surfaces like the scutes of the Crocodilia.

As has been seen, the angles of the scales of *Gyroptychius* are apt to become rounded off, so as to present a transition from the rhomboid to the cycloid contour, and, hence, it is less surprising than it seems at first sight, to find fishes with eminently cycloid scales, so similar, in all the essential features of their organization, to *Glyptolæmus*, *Gyroptychius*, and *Glyptopomus*, as imperatively to demand a place near them in any natural arrangement.

Holoptychius (Agassiz), for example, has a depressed head (though deeper than that of *Glyptolæmus*), and a conically tapering caudal extremity; the orbits are situated far forwards and the gape extends far back. The frontal bones are distinct from one another, and from the parietals, which last are large and co-adapted, though quite distinct; the occiput is covered in by three bones, a median and two lateral; there are two principal and a number of lateral jugular plates, and there is no rhomboidal median jugular plate interposed between the principal jugulars. Some of the teeth are larger than the others, and longitudinally striated at their bases. The paired fins are very acutely lobate, and there are two dorsal fins placed in the posterior half of the body. The ventral fins are situated under the first dorsal, and are succeeded by a single anal.

FIG. 5.



Restoration of *Holoptychius*.

Thus far, the reader who compares this description with that of *Glyptolæmus* already given, will find the two essentially identical. But the tail of *Holoptychius* differs from that of *Glyptolæmus*, in that it is little more than semi-rhomboidal, the upper moiety being far less developed than the lower,* and the scales are, in form and sculpture, widely different from those of the latter genus.

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* In my restoration of *Holoptychius* (Dr. Anderson's "Dura Den," p. 69) I have represented the fish with a diphycercal tail; but I am now prepared to admit that the evidence on which I rested this conclusion was not trustworthy, and that Sir Philip Egerton's view of the case is in all probability correct. However, I must say, that I have never yet seen a *Holoptychius* with its caudal extremity in a perfectly satisfactory state of preservation.

That *Platygnathus* (Agassiz), if we restrict the name to the fish whose caudal extremity is figured by Agassiz ("Vieux Grès Rouge," Tab. 25), is very closely allied to *Holoptychius* cannot be doubted; indeed, the only serious question regarding it, in the absence of further materials for its reconstruction, seems to be, whether it should really form a separate genus; so that I may pass on to another generic type, *Glyptolepis* (Agassiz).

This genus is briefly mentioned in the "Recherches sur les Poissons Fossiles," ii. p. 179, but Agassiz first described and figured species of it in the "Monographie des Poissons du Vieux Grès Rouge," p. 62, where *Glyptolepis* heads the family of the "Célacanthes," and is said to comprise fishes of moderate size, with pyriform bodies, and with heads which are small, short, flattened, and have an almost semicircular contour. The rami of the mandible are stated to be beset throughout their length with a single series of small, equal, conical teeth, which seem to approach those of *Dendrodus* and *Holoptychius* in structure, and to have a dendritic pulp cavity surrounded by folded dentinal walls. *Glyptolepis microlepidotus*, however, is said (p. 65) to possess large teeth alternating with small ones in the lower jaw. The upper jaw projected beyond the lower a little, and had similar teeth. The throat was provided, as "in all ancient " Cœlacanths and in *Polypterus*, with two mobile triangular plates, " which replace the branchiostegal rays."

The scales were delicate, rounded, and so much imbricated that the anterior one sometimes covered more than half of its successor. Their upper faces were entirely smooth, and covered with a delicate layer of enamel, which, apart from some concentric lines of growth, exhibited no ornamentation. Their inferior faces were also smooth, and formed by a very delicate layer of bone. The mass of the scale was formed by an osseous and spongy substance, adorned with fine rays, which radiated from the centre of the scale. These rays were intersected by concentric and circular lines, so that a scale, whose smooth layer is worn away, presents a number of small elongated cells, disposed in circular series, almost like the seats of an amphitheatre.

In the "Additions et Corrections," (l. c., p. 140), Agassiz adds a description of the scales of *Glyptolepis elegans*, which supplies an important correction to that just given. Referring to Tab. 21 a, he says, "The figure 2 a represents a scale of its natural size, and " fig. 2 the same magnified. *The folds of the surface which con-" stitute the ornaments of the visible portion of the scale* are more

" distant than in the foregoing species." Thus it is admitted that *Glyptolepis* has not smooth, but sculptured scales, as, indeed, the name of the genus implies.

Agassiz enumerates a caudal, two dorsal, and two anal fins, but states that the existence of pectorals is doubtful, and that, in any case, they must have been small and inconsiderable. The ventral fins, on the other hand, are said to possess a singular structure, " which is also to be found in *Megalichthys*." A series of plates extends as a pointed band along the belly, and, becoming free at its posterior extremity, carries numerous rays on both sides, and thus forms a ventral fin, which, from the manner in which its rays are disposed, is very like an eel's tail. (Tab. 21, fig. 2.) I have examined the specimen here referred to, which forms a part of Sir Philip Egerton's collection, and, with Professor Pander, I feel satisfied that the fin in question is the very long, acutely lobate, pectoral, bent back in such a manner, that the proximal half of its posterior edge is covered by the lower margin of the abdomen of the fish.

Professor Agassiz goes on to say that the two dorsals are opposed to the two anals, and are situated so far back that the caudal directly follows them. They are so close together that the last ray of the first touches the first ray of the second. The second dorsal and anal are higher than the first, and the caudal is large, heterocercal, and triangular, appearing to be almost vertically truncated; its superior division bears numerous little fulcra.

Hugh Miller (" Old Red Sandstone," 1841,) made some important improvements upon Agassiz' description and definition of *Glyptolepis* He pointed out with great justice (and figured a specimen demonstrating the fact), that there is only one anal, the second, or posterior of Agassiz, the ventrals having been mistaken for an anterior anal, and he describes and gives a sketch of the sculptured outer surface of the scales.

Professor Pander, in the Monograph already cited, has carried the work of rectification still further, though even he ventures upon no restoration of *Glyptolepis*, seeming to be unacquainted with the figure of the body of the fish, from a specimen more complete than any of those of Agassiz, or of his own, given by Hugh Miller.

In addition to what was already known, he states that the principal jugular plates are separated, anteriorly, by a small rhomboidal one, and he makes the observation that " these plates, which among " living fishes occur double only in *Polypterus*, and are among fossils " known only in *Osteolepis*, *Diplopterus*, *Megalichthys*, and *Gyroptychius*, lead to the supposition that the composition of the cranial " and facial bones will differ in no important respect from what is "found in them;" and this supposition is, he states, confirmed by the similarity of the upper and lower jaws and teeth. Behind the jugular plates, and applied to their hinder edges, Professor Pander finds two others, which meet in the middle line, and resemble those which lie upon the under surface of the pectoral arch in *Polypterus*.

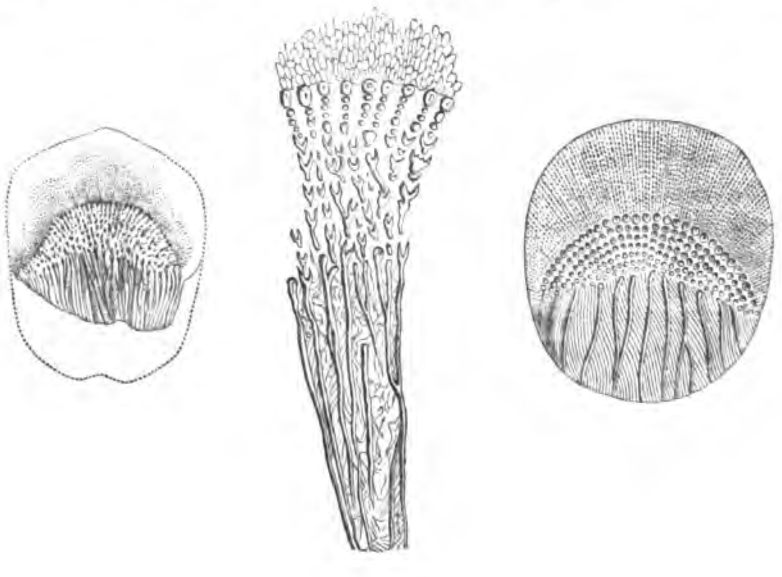
The scales are, in general, rounded, sometimes circular, sometimes oval, sometimes more or less quadrate, by reason of the less rounding off of their angles. They overlap in different degrees, and their external sculpture is different in different parts of the body, whence arises such an amount of unlikeness, that different species might readily be founded on scales from different regions.

The sculptured surface presents two divisions, one, more anterior, exhibits small tubercles with projecting points, which are convex posteriorly, concave anteriorly, and are disposed in regular series converging towards a central point, which, however, they do not reach.

The posterior segment is covered with wavy longitudinal costæ, which gradually diminish in thickness from the anterior towards the posterior edge.

Professor Pander gives a figure of this peculiar sculpture, a woodcut copy of which I subjoin, and side by side with it a careful drawing of the sculpture of the scale of a *Glyptolepis* from Wick, in an even better state of preservation.

FIG. 6:—The two left hand figures represent the scale from Wick of the natural size and its sculpture magnified; the right hand figure is copied from Pander's Monograph.

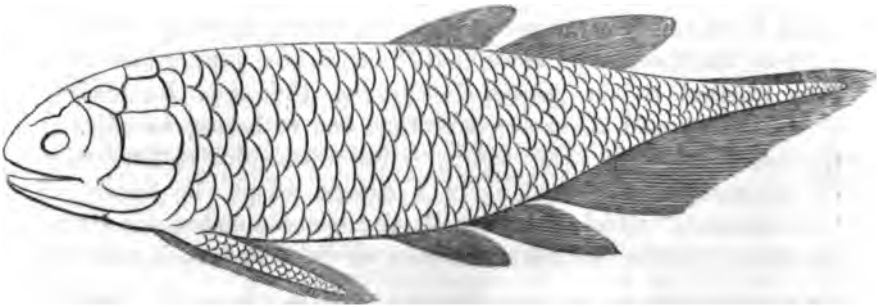


There can be no doubt that the scales of *Glyptolepis* possess the ornamentation here represented. Not only does Professor Pander positively state that the scale figured by him was worked out from a Lethen Bar nodule, and formed part of the unquestionable *Glyptolepis* represented in his Plate 7, fig. 4; but the specimen of *Glyptolepis leptopterus* represented by Agassiz in the "Vieux Grès Rouge," Tab. 21, fig. 2, and now in Sir Philip Egerton's collection, has obviously sculptured scales and cranial bones. And I find that by scraping away the inner layers of the scales of undoubted examples of this genus, in the Museum of Practical Geology and in that of the Royal College of Surgeons, the points and ridges of the sculpture remaining imbedded in the rock are easily displayed. The clear recognition of the fact that this elegant structure really characterizes *Glyptolepis* is of great importance, for, in the first place, it enables one to discriminate between *Holoptychius* (whose scales have no semilunar area of backwardly directed points) and *Glyptolepis*, and, in the second place, it places beyond a doubt the justice of Professor Pander's conclusion that the scale figured by Miller in the "Footprints," as appertaining to *Asterolepis*, really belongs to *Glyptolepis*.

Pander states that the rays of the median fins are supported upon long interspinous bones, and that the paired fins are very much approximated; the very long pectorals extending far beyond the bases of the ventrals, which are very broad and strong.

Specimens which I have examined show, that the parietal bones of *Glyptolepis* are large, and, like the frontals, distinct from one another; in their form and relative proportions, these bones very much resemble those of *Holoptychius*. There are three bones in the superior occipital region, one median and two lateral. A triangular, single or divided, squamosal fits in between the parietal, the external of the three superior occipital bones, and some indistinctly defined supratemporal and postorbital plates; again, as in *Holo-*

FIG. 7.



Restoration of *Glyptolepis*.

ptychius. In the opercular apparatus, the operculum and sub-operculum are large, subquadrate, and nearly equal in size. There are large dendrodont teeth (very well shown in a large specimen in Sir P. Egerton's collection) upon the inner side of the mandible. The principal jugular plates are large, but no specimen I have seen gives clear evidence of others. There is a well marked lateral line.

Apart from what has been done by Agassiz, Miller, and Pander, I think I can venture to assert from my own investigations that the woodcut fig. 7 gives an essentially faithful restoration of *Glyptolepis.** But a comparison of this figure with that of *Holoptychius,* given above, is sufficient to prove the close affinity of the two genera,—in fact, their family relationship.

Pausing now, to look back over the ground which has been traversed, we find that the six genera which have been discussed, viz., *Glyptolæmus, Glyptopomus, Gyroptychius, Holoptychius, Platygnathus,* and *Glyptolepis,* possess the following characters in common:—Two dorsals, acutely lobate paired fins (ventrals of *Glyptolepis?*); principal and lateral jugular plates, and no branchiostegal rays; more or fewer large teeth with grooved bases, and consequently folded dentine; sculptured scales and cranial bones,—among which last are to be noted three occipital plates,—large, distinct, parietals, and equally distinct frontals. In short, they constitute a family of Ganoids, which I propose to call GLYPTODIPTERINI, and which may again be subdivided into two groups, or subfamilies, the one, which might be called the rhombiferous Glyptodipterini, containing the genera *Glyptolæmus, Glyptopomus,* and *Gyroptychius,* with diphycercal tails, and for the most part rhomboidal scales; and the other, which might be termed the cycliferous Glyptodipterini, containing *Holoptychius, Platygnathus,* and *Glyptolepis,* with heterocercal tails and cycloid scales.

Professor Pander has endeavoured to prove that the teeth known as *Dendrodus* belong to fishes of the genus *Gyroptychius.* The evidence brought forward in support of this view, however, appears to me to be hardly sufficient to demonstrate its accuracy; though I think it extremely probable that the teeth and jaws, which have been referred to the genera *Dendrodus, Cricodus, Lamnodus, Platygnathus,* and *Rhizodus,* will turn out to belong to allies of *Gyroptychius,* or, in other words, to fishes belonging to the family of Glyptodipterini. And again I cannot adopt the family of "Dendrodonts" which Professor Pander has established for *Gyroptychius, Cricodus,* &c., partly because, as he defines it, it seems to me to separate naturally allied genera, and, still more, because the "dendrodont" character is quite as strongly marked in other fishes, *e.g.*, *Megalichthys*, which certainly do not belong to the same family as *Gyroptychius*, though undoubtedly related to it.

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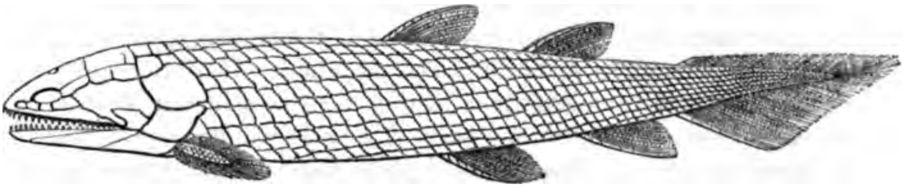
* It may be that the ventral fins are lobate, but I have seen no specimen justifying that conclusion.

The resemblances which obtain between *Gyroptychius*, on the one hand, and *Osteolepis*, *Diplopterus*, &c. on the other, have been well pointed out by Professor Pander, whose Monograph upon the Saurodipterini is not less excellent than that already cited, though it should not be forgotten that Hugh Miller long ago published an excellent restoration of *Osteolepis*.* *Diplopterus* has, in fact, the elongated form, depressed head, forward orbits, long gape, and conically tapering candal end of the body, which characterize *Glyptolæmus*. The pectoral fins are similarly, though not so acutely, lobate, and the lobate ventrals are situated far back, as in the last-named genus. The second dorsal is over the anal, and the caudal fin is rhomboidal and diphycercal.

On the other hand, *Osteolepis*, though similar to *Diplopterus* in many essential respects, has a very inæquilobed tail, much like that of *Glyptolepis*. But in *Osteolepis*, as in its most nearly allied genera, the cranial bones and the scales are quite smooth. The three occipital plates of the skull remain distinct, but the other bones of the roof of the cranium have coalesced, so as to form two bucklers, an anterior and a posterior; in which, however, the outlines of the primitive cranial bones, which have, on the whole, an arrangement similar to that which obtains in *Glyptolæmus*, are traceable. There

FIG. 8.



Restoration of *Osteolepis* (after Pander).

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* *See* "The Old Red Sandstone," Pl. iv. fig. 1, *Osteolepis major*. It appears from this figure that even the lobation of the pectoral fin had not escaped Hugh Miller, though he does not particularly refer to it in the text. Before Professor Pander's work appeared in this country, I had obtained from Caithness, by the well-directed activity of Mr. Peach, and placed in the Museum of Practical Geology, a series of specimens illustrating all the chief structural characters of *Osteolepis* as detailed above. The lobate pectorals of *Osteolepis* and *Diplopterus* are exhibited very well by specimens in the Hunterian and British Museum; the fact that "small ganoid scales are continued upon" the bases of the pectorals being noted in the description of No. 567 in the Catalogue of the former Museum.

are no lateral jugular plates, but the principal jugular plates are separated, anteriorly, by an azygos rhomboidal plate.

The family of the SAURODIPTERINI, characterized by its two dorsals; less acutely lobate paired fins; jugular plates and no branchiostegal rays; smooth scales and cranial bones (among which last are three distinct occipital plates, while the other cranial bones have more or less coalesced), is thus very distinct from, though allied to, that of the Glyptodipterini. It comprises not only the genera *Osteolepis*, *Diplopterus*, and *Triplopterus* (?), but also, as I believe, a genus which has a later range in time than these, viz., the *Megalichthys* of the Coal, although the want of acquaintance with the fins of this genus renders my conclusions as to its affinities less secure than I could wish.[*] Agassiz does indeed affirm that *Megalichthys* has lobate fins, in a passage cited above (p. 7); but as he merely mentions the fact incidentally, I do not like to lay too much stress upon it. Nevertheless, the skull and scales of *Megalichthys* accord so closely, both histologically and morphologically, with those of the better known Saurodipterines, that I entertain little doubt as to its real place in the latter family.

Megalichthys has two principal, many lateral, jugular plates; and a single rhomboidal, azygos plate is placed between the anterior ends of the two principal jugulars. Between the upper margins of the opercula and in the upper occipital region, lie three bony plates, whose signification Professor Agassiz considers to be "somewhat enigmatical," but which really correspond exactly with the three bones which occupy the same position in the Glyptodipterini and Saurodipterini. What Agassiz terms the frontals are certainly the long parietals, whereas those which he calls "ethmoids" are the frontals. His "moignon intermaxillaire" is a crescentic shield, which terminates the head anteriorly, and presents distinct indications of a division into a number of pieces; the contour of the proper premaxillary portions, separated by a median suture, which form the lower and anterior boundary of the shield, being very well defined. The other parts entering into this shield represent, I believe, the prefrontals and the ethmoid. If it were amalgamated with the frontals and these with one another, we should have an almost exact reproduction of the anterior cranial buckler of *Osteolepis.* In a well preserved specimen of the skull of *Megalichthys* before me, the orbits are small circular cavities, placed at about the junction of the anterior and middle thirds of the head. They are bounded, in front and below, by a small triangular bone (like a lachrymal) as in *Polypterus;* below, by a small part of a large suborbital bone, whose anterior margin joins the premaxilla and its inferior margin the maxilla; below and behind, by another suborbital bone, fitted in between the preceding, the maxilla, and a postorbital bone. The maxilla, large and long, is narrow anteriorly, where it abuts upon the bone termed "preoperculum" by Agassiz; like the premaxilla, its edges are beset with small teeth. Agassiz says, "Le coté antérieur du mufle est "élégamment échancrè au milieu et renflè en un bec, tres obtus, "qui porte dans notre exemplaire une grosse dent canine;" and on making a transverse section of a *Megalichthys* snout I found a median, stout, backwardly projecting ridge of bone, containing two large alveoli, one on each side of the middle line. The one of these alveoli exhibits the section of the base of a large tooth with greatly folded dentine.

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[*] Sir Philip Egerton long since arrived at and published this conclusion in his arrangement of the Fossil Fishes in Morris's Catalogue. More recently Prof. Pander expresses the same conviction in the following terms: "Sehr gerne möchten wir aber ein anderes Genus noch zu den Saurodipteridæ bringen, das durch den Bau seiner Kopfknochen; durch die Gestalt seiner Schuppen, seiner Zähne und hauptsächlich durch die mikrospische Structur seiner harten Theile sich eng an *Osteolepis* anschliesst und aus der Kohlenformation herstammt. Es ist der Genus *Megalichthys*, von dem wir leider die Beschaffenheit und Lage seiner Flossen gar nicht kennen."—Pander, l. c., p. 5.

While the exoskeleton of *Megalichthys* is exceedingly similar to that of *Diplopterus* and *Osteolepis*, the endoskeleton presents a remarkable advance on that of any other Saurodipterine, in that both the centra and the neural arches of the vertebral column are thoroughly ossified. Excellent specimens of these vertebræ are to be seen in the British Museum.

The Saurodipterini and Glyptodipterini being thus separated from other Palæozoic fishes, as well-defined families, perfectly distinct from one another, though closely allied by the community of characters displayed in the number, structure and disposition, of their fins, the absence of branchiostegal rays and their replacement by jugular plates; we have next to consider what other families of fish, if any, should be ranged alongside of them, or in other words, what are the limits and what the importance of the larger group, formed by the association of these families.

In the first place, I conceive there can be no doubt that the CTENODODIPTERINI, a family justly established by Professor Pander* for the reception of *Dipterus* and its immediate allies, must take its place in close juxtaposition with the Saurodipterini and Glyptodipterini, seeing that it possesses all those structural peculiarities which are common to these two families. In fact, as Hugh Miller * originally pointed out in successive notices, *Dipterus* has the dorsal fins placed far back; acutely lobate pectorals and ventrals;† no branchiostegal rays, but jugular plates instead of them; and a single anal. The caudal extremity of the body tapers off to a point, and has the lower lobe of the fin very much larger than the upper; the scales are cycloid. Thus far, in fact, the definition of Ctenododipterini agrees with that of the Glyptodipterini; but the

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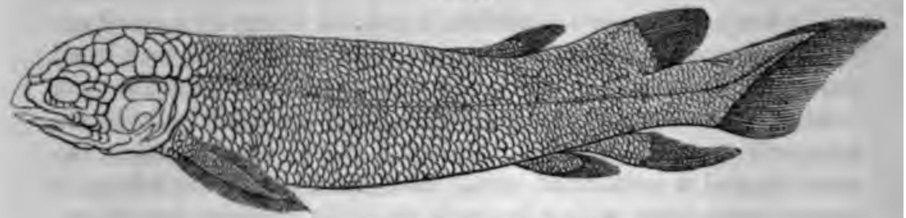
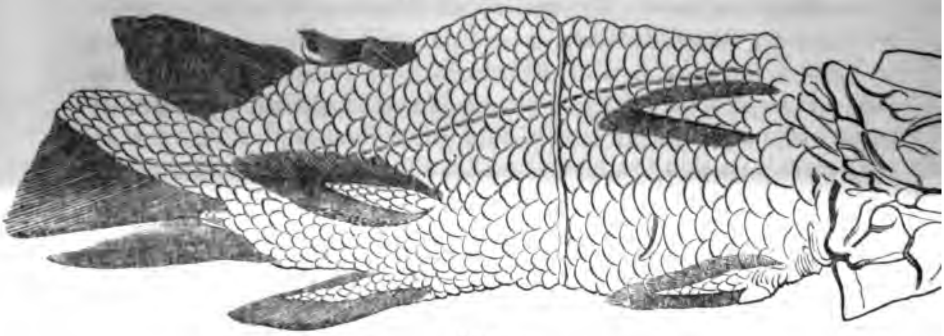
* Under the name of *Ctenodipterini.* Sir Phillip Egerton has, I think, given good reasons for the slight change I have adopted. *Vide infrà*, p. 55.

FIG. 9.



Restoration of *Dipterus* (after Pander).

FIG. 10.‡



Dipterus.

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* *See* "Old Red Sandstone," "Footprints of the Creator," and "Sketch Book of Popular Geology." It is much to be regretted that Professor Pander should have been wholly unacquainted with these works when he wrote his Monograph on the *Ctenododipterini*, and that he has consequently inadvertently failed to do justice to the great merits of Hugh Miller, who made known almost the whole organization of *Dipterus*, and anticipated the most important part of Prof. Pander's labours in this field.

† *See* Prof. Pander, l. c.

‡ The woodcut, fig. 10, represents the same specimen as that figured by Sir Philip Egerton in "Siluria," ed. 2, p. 287, but of the natural size. It exhibits the characters of the paired fins of *Dipterus* remarkably well.

former differ from the latter in the smoothness of their scales; in the structure of the roof of the cranium, whose constituent bones are anchylosed into a singular shield, presenting some resemblance to the cephalic shield of *Accipenser;* and lastly, and chiefly, in the peculiar form of the lower jaw, which much resembles that of a Cœlacanth, and in their dentition, so well made known by Hugh Miller, whose researches have been fully confirmed by Professor Pander.

In the next place, the true CŒLACANTHINI have a no less well-defined right to occupy a similar position.* I say the *true* Cœlacanthini, because the term "Cœlacanth" has been used by different palæontologists with such very different meanings, has been made in some cases to include so much, and in others to include so little, that I feel it to be necessary to define precisely the sense in which I employ it here. I intend it, then, to designate that family of fishes of which the genus *Cœlacanthus* of Agassiz is the type, a family which, thus restricted, is as well defined and natural a group as any in the animal kingdom, but, at present, can embrace only the genera *Cœlacanthus, Undina,* and *Macropoma.*

In order to make this clear, however, I must enter at some length into a historical and anatomical criticism of the Cœlacanths as a family of fishes.

In establishing this family ("Recherches," vol. ii. p. 168), Professor Agassiz dwells particularly upon the hollow fin rays of the typical genus; the absence of joints in some part of the length of most of those fin rays; the presence of interspinous bones in the caudal fin; the continuation of the vertebral column between the two lobes of that fin, and the prolongation of the caudal extremity beyond it as a filamentary appendage. With *Cœlacanthus, Undina, Macropoma, Hoplopygus, Uronemus, Holoptychius, Glyptosteus, Glyptolepis, Psammolepis, Phyllolepis, Ctenolepis,* and *Gyrosteus* are associated; and it is a curious circumstance that while *Holoptychius* takes its place among the Cœlacanths, without any special demonstration of its right to that position, Professor Agassiz hesitates touching *Macropoma,* and, while admitting it into the family on account of the striking analogy of its general physiognomy, and of the form, arrangement, and structure of its fins, adds: "I must "admit that side by side with these resemblances, the two types "exhibit profound differences," . . . "which will perhaps, in "the long run, necessitate another arrangement."

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* Several years ago Sir Philip Egerton strongly drew my attention to the close affinity between the *Cœlacanthini* (*mihi*) and what I have termed the *Glyptodipterini,* particularly showing the importance of the lobate paired fins and of the double dorsals common to the genera of both families (which Sir Philip Egerton was inclined to group under the one head of '*Cœlacanths*'), and illustrating his views by a synopsis of the genera. From the study of that synopsis I trace the gradual clearing up of my own ideas respecting the difficult subject with which this preliminary essay attempts to deal.

The idea that *Cœlacanthus* inclined more to *Holoptychius* than to *Macropoma*, appears to have found still more favour with Professor Agassiz at the time of the publication of his great work on the Fishes of the Old Red Sandstone; and the consequences of this inclination were the more important from the fact, that Agassiz held that the teeth, properly distinguished by Professor Owen under the name of *Rhizodus*, belonged to *Holoptychius*. For *Glyptolepis* and *Platygnathus* were undoubtedly closely allied to *Holoptychius*, while *Dendrodus*, *Lamnodus*, and *Cricodus* had much in common with *Rhizodus*; hence, as these dendrodont teeth were conceived by Agassiz to belong to the fish whose bony plates and scales had received the names of *Asterolepis*, *Bothriolepis*, &c., it was natural that he should include all these genera under the common title of "Cœlacanths;" while *Macropoma* and *Undina* were regarded with doubt, and, in fact, almost excluded from the group ("Vieux Grès Rouge," p. 64).

Here, however, I cannot but believe, that the founder of fossil ichthyology has, for once, gone off upon a wrong scent. For later investigations have made it, to say the least, extremely improbable that *Asterolepis* (Ag. & Miller) has anything to do with *Cricodus*, or with *Holoptychius*, whatever may be the relation of the two latter genera; and I shall now endeavour to prove that, while *Cœlacanthus* is so intimately connected with *Undina* and *Macropoma*, as to render the generic distinction of the three forms a matter of minute detail, its relations with *Holoptychius*, although clear and distinct so far as they go, are, at most, those of a member of the same suborder.

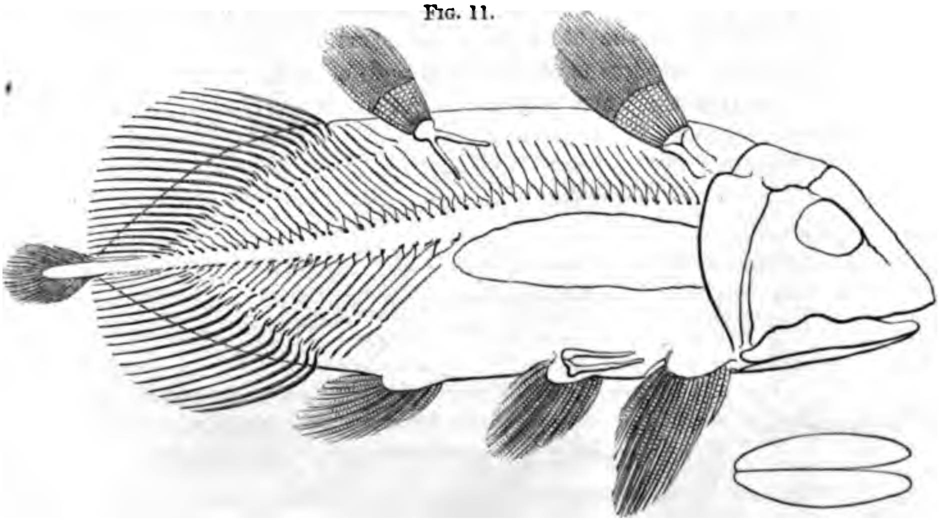
But first, what are the characters of the genus *Cœlacanthus*? This question is by no means so easily to be answered as might be imagined, but the following facts appear to furnish a conclusive reply to it.

The type species of *Cœlacanthus*, that on which the genus was founded by Agassiz, is the *C. granulatus* of the Magnesian Limestone; two figures of which are to be found in the "Recherches," while a third, representing another specimen, is given by Sir Philip Egerton in King's "Permian Fossils." Singularly enough, neither of these specimens retains its head, nor are the paired fins preserved;

but the characters of the spinal column, of the median fins, of the scales, and of the tail, are so exactly those exhibited by the *Undina* of Münster (of which sundry complete specimens exist), that the very close affinity of the two genera is beyond doubt. Agassiz, in fact, proposes to distinguish them only by their teeth; *Cœlacanthus* having, in his opinion, conical and recurved, while *Undina* has flat, pavement-like and tuberculated teeth. That Münster was correct in assigning such teeth to *Undina* I have satisfied myself by the examination of a well-preserved specimen of *U. Köhleri* in Lord Enniskillen's collection; but what evidence is there that *Cœlacanthus* has a different dentition? Agassiz was led to believe that the teeth of the latter genus are conical, by the fact that the specimen of a fish named by him *C. Münsteri* has such teeth. I am again indebted to the Earl of Enniskillen, of whose collection this specimen forms a part, for the opportunity of verifying the statement; but I must at the same time express my entire concurrence in the opinion previously expressed to me by Sir Philip Egerton, that the so-called "*Cœlacanthus*" *Münsteri* is not a *Cœlacanthus* at all.

For, as I have stated above, there can be no doubt that *Cœlacanthus* (*C. granulatus* being the typical species) was, in all the great features of its organization, similar to *Undina*; so that, contrariwise, any fish which differs in essentials very widely from *Undina* can be no *Cœlacanthus*.

FIG. 11.



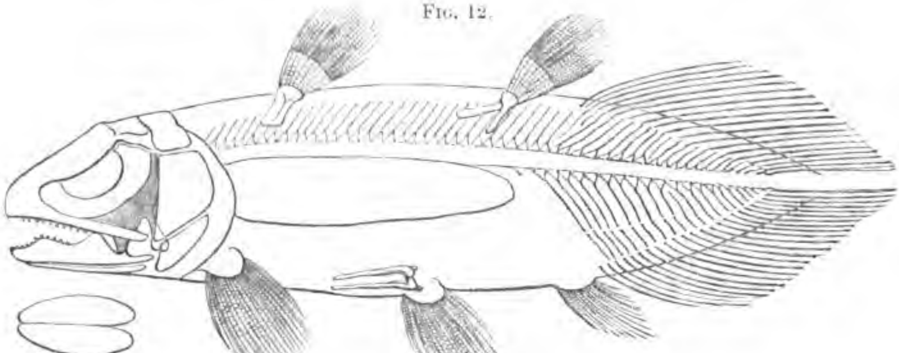
Restoration of *Undina*. (Partly after Münster, partly from Lord Enniskillen's specimen. Below the head are the contours of the jugular plates.)

But *Undina* has two dorsal fins, each supported by but a single, very peculiarly shaped, interspinous bone; it has a large caudal fin, whose rays are supported by interspinous bones, and which is divided into two equal lobes by the unossified spinal column; the latter extending beyond the caudal fin as a tufted appendage, or second caudal, provided with very short fin rays. There is a single anal fin; the pectoral and ventral fins are well developed and obtusely lobate; the pelvic bones are remarkably large, and are united together by transverse branches, which extend from the posterior extremities of each and meet in the middle line; there are no dorsal ribs and no proper branchiostegal rays, but instead of them, two broad principal jugular plates. Finally, the scales, large, thin and cycloid, are ornamented with elongated splashes and dots of enamel. On the other hand, "*Cœlacanthus*" *Münsteri* exhibits no one of the positive characters here enumerated, while it *has* ribs attached throughout the dorsal region; in fact, I am inclined to consider it the type of a new genus allied to *Phaneropleuron*.

I have seen no specimens of the other species of *Cœlacanthus* enumerated by Agassiz, and I can therefore say nothing about them. But *Cœlacanthus caudalis* (Egerton) is a true Cœlacanth, as I have convinced myself by examination of the specimen, to which the figure in King's "Permian Fossils" does not quite do justice.

As the case stands, then, it appears that there is no evidence that the supposed distinction between *Cœlacanthus* and *Undina* really obtains; while, on the other hand, a recent careful comparison of well-preserved specimens of *Undina* and of *Macropoma* has convinced me that these two genera are not much less closely allied.

FIG. 12.



Restoration of *Macropoma*.

All the structural characters, in fact, which have been enumerated above among the peculiarities of *Undina*, are equally well marked in *Macropoma*, except that, hitherto, I have been unable to meet with the caudal appendage in the latter, and that the teeth are more distinct and cylindrical. But further than this, as Dr. Mantell originally suspected, and as Professor Williamson has since demonstrated, *Macropoma* exhibits the peculiarity, without a parallel, so far as I know, among fishes of other families, of having the walls of its air bladder ossified. Now, I find good evidence of the existence of a similarly ossified air bladder, not only in *Undina*, but in a well-preserved specimen of a new genus of Cœlacanth from the Lias (described in the subjoined note by Sir Philip Egerton), in the Museum of Practical Geology.*

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* *Holophagus Gulo.*

Mr. Harrison's specimen wants the anterior portion from the dorsal and pectoral fins forwards. From the insertion of the dorsal fin to the extremity of the tail it measures 11½ inches, and 4½ inches in depth. The stomach is distended with a recently swallowed *Dapedius*, and a large coprolite occupies the rectum. The first dorsal fin springs (as in *Macropoma*) from a single disc, resulting from the coalescence of the interneural spines. It contains eight long, thick, undivided, and multiarticulate rays. They are beset with numerous short spines or tubercles. The second dorsal is situated 4 inches behind the first. Between the two is seen a strong bifurcate interneural ossicle, which has been displaced forwards from its proper position at the base of the fin. The second dorsal fin contains sixteen rays. The anterior ones are short and slender. The succeeding ones are long, broad, and multiarticulate, but not tuberculate. The base of the fin is obtusely lobate, with a scaly investment. The pectoral fins are much mutilated. Judging from what remains of them, and from some indistinct impressions, they seem to have been of great size. The anal fin occurs immediately below the second dorsal fin, with which it corresponds in form and structure, but contains many more rays. The ventral fins are mutilated, but their position below the first dorsal fin is indicated by the preservation of a pair of strong T-shaped pelvic bones, having their longer limbs directed forwards, and nearly reaching the base of the pectoral fins. The caudal fin is of great size, and presents in an eminent degree the most special and characteristic feature of the *Cœlacanthus* family, namely, the interposition, in the caudal region, of an interneural between the neural and dermo-neural spines. The base of this spine abuts upon the extremity of the neural spine, and unites with the true fin-ray by an overlap or splice. This structure coincides with that observed in *Undina*. In *Macropoma* the bone of the interneural spine is bifurcate for the reception of the distal extremity of the neurapophysis. A small supplemental fin extends an inch beyond the larger caudal fin, as in *Undina* and *Cœlacanthus*. The notochord is unossified. The apophyses, both above and below, have very wide bases. The scales are curvilinear, and covered with a vermiculate pattern on the upper surface, occasionally broken up into small tubercles.

In the Woodwardian Museum at Cambridge there is the head and part of the trunk of a *Cœlacanthus*, from the Kimmeridge Clay at Cottenham. The head shows the frontals, prefrontals, and lower jaw, with the tympanic attachments. The glossohyal plate is double, as in *Holoptychius*. The scales are roughly undulate, coarser in pattern than in *Undina*, *Cœlacanthus*, and *Holophagus*, but not absolutely tuberculate, as in *Macropoma*. One fin is preserved, probably the left pectoral. It is lobate, broad, and strong. The operculum is triangular, the frontals short, and the prefrontals descend at an abrupt inclination.

Thus, leaving open the question as to the identity of *Cœlacanthus* with *Undina*, and also that whether *Uronemus* and *Hoplopygus* (which I have not seen, and concerning which no details are given by Agassiz) are Cœlacanths, or not; it appears to be certain that fishes closely allied to *Cœlacanthus granulatus*, and known under the generic appellations of *Undina* and *Macropoma*, form an exceedingly well-defined family, to which the term CŒLACANTHINI may with propriety be restricted, and which has ranged in time, with remarkably little change, from at least as early as the Permian formation to the Chalk, inclusive.

The Cœlacanthini, as thus understood, are no less distinctly separated from other fishes than they are closely united to one another. In the form and arrangement of their fins; the structure of the tail and that of the cranium; the form and number of the jugular plates; the dentition; the dorsal interspinous bones; the pelvic bones; the ossified air bladder; the Cœlacanthini differ widely from either the Saurodipterini, the Glyptodipterini, or the Ctenododipterini; but, on the other hand, they agree with these families and differ from almost all other fishes, in the same respects as those in which the several families just mentioned, have been shown to agree with one another; viz., the number of the dorsal fins, the lobation of the paired fins, the absence of branchiostegal rays, and their replacement by jugular bones.

Their special affinities among these three families appear to me to lie chiefly with the Ctenododipterini: the scales, the arrangement of the teeth, and the form of the lower jaw in the two families presenting many curious analogies.

The Glyptodipterine family contains, as we have seen, both cycliferous and rhombiferous genera. Following out the alliances of the former subfamily, we have found reason to include the cycliferous Ctenododipterini and the cycliferous Cœlacanthini in the same larger, or subordinal, group with the Glyptodipterini. If, on the other hand, we now trace out the congeners of the rhombiferous subfamilies, we arrive, as has been seen, at the Saurodipterini; and the question now remains, what other rhombiferous Ganoids naturally arrange themselves at this end of the series?

So far as I am aware, there is no other fossil rhombiferous Ganoid which comes within the scope of the sum of characters common to the Saurodipterini, Glyptodipterini, Ctenododipterini, and Cœlacanthini; but among recent fishes there is one, *Polypterus*, which very nearly approaches the required standard, and is unquestionably closely allied to the Saurodipterini.

Polypterus, in fact, has an elongated body, with a depressed head, and a conically tapering caudal extremity. The orbits are situated in the fore part of the head, while the gape extends far back. There are two large principal jugular plates, without lateral or median plates. The pectoral arch is covered inferiorly by two triangular osseous plates, which meet in the middle line, and are superficial to the so-called coracoids. The pectoral and ventral fins are lobate. The caudal fin is rhomboidal and nearly diphycercal.*

FIG. 15.

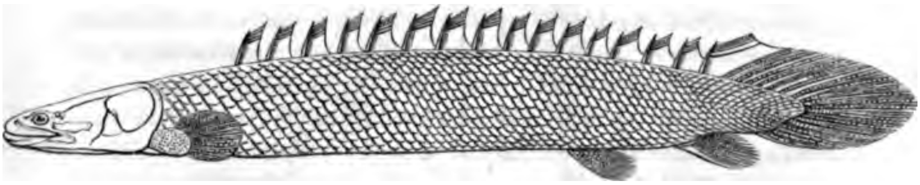

Figure of *Polypterus* (after Agassiz).

A comparison of these characters with those which have been assigned to *Glyptolæmus*, or to *Osteolepis*, reveals at once the close connexion of the three genera,† from which however *Polypterus* differs in many important particulars.

Thus the parietal bones of *Polypterus* are much smaller, in proportion to the frontals, than are those of either *Osteolepis* or *Glyptolæmus*, and with age they unite with one another and with

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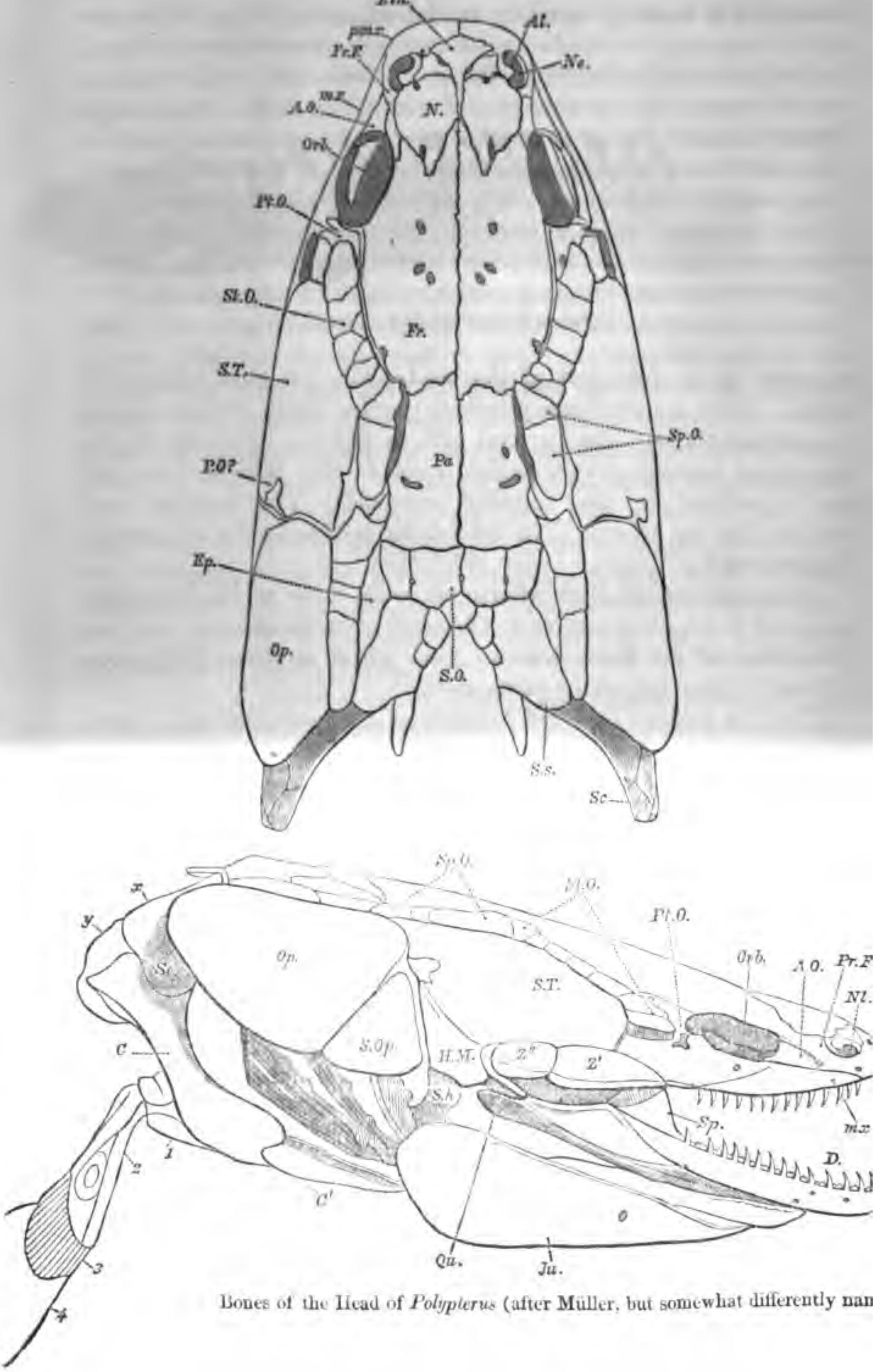
* *See* the careful account of the tail of *Polypterus*, by Kölliker, "Ueber das Ende der Wirbelsäule der Ganoiden."

† I do not know that any one has hitherto pointed out in detail the very close relation between *Polypterus* and the fossil genera enumerated above; but Professor Pander has enunciated conclusions nearly similar to my own in the following passage (Ctenodipterinen, p. 3.) : —

"Ueberhaupt ist es merkwurdig zu sehen wie *Polypterus* so ganz in den Hintergrund
" gestellt wird, Herr J. Müller (Ueber d. Bau.) sagt ausdrücklich 'Fur den *Polypterus*
" 'kenne ich unter allen fossilen Ganoiden keine analogie.' Und Herr Pictet wieder-
" holt dasselbe gleichfalls, 'aucun fossile n'a été rapproché de ce genre remarquable.'
" Wir werden in Zukunft sehen dass wenn man überhaupt ein Recht hat, wie es doch
" wahrscheinlich ist, die ausgestorbenen Geschlechter der Devonischen Formation jetzt
" noch lebenden Fischen an die Seite zu stellen, mehrere durch ihre Zahnbau, durch die
" grossen Knochen-platten und die Stelle der Kiemenhaut-strahlen, durch den Bau der
" Kopfknochen, u.s.w., eine grössere analogie mit dem *Polypterus* als seinen Amerika-
" nischen Zeitgenossen besitzen."

In his subsequent memoirs Prof. Pander has not followed out to their logical result the views so sagaciously indicated in this paragraph, which I think would be identical with those I had arrived at before I read it, and now publish.

Figs. 16 and 17.



Bones of the Head of *Polypterus* (after Müller, but somewhat differently nan the frontals, into a continuous shield, as seems to have been the case in *Dipterus*.

The upper part of the occipital region is covered by a number of more or less irregular plates, which, however, may be readily shown to correspond with dismemberments of the three plates found in the Saurodipterini, &c. There are neither lateral, nor median, jugulars; the teeth have simple pulp cavities; and what is most remarkable, the dorsal fin, instead of being double, is incompletely broken up into a number of pinnules, which extend for nearly the whole length of the back. Furthermore, *Polypterus* has a spiracle, a structure of which I find no trace in any of the fossil genera.

It may conduce to clearness if, before proceeding farther, I now endeavour to put the results of the preceding statements into a readily comprehensible and definite form, and show their bearing upon the classification of the Ganoids, and more particularly upon that of the fossil Ganoidei. To this end I have prepared the following synoptical table:—

ORDO GANOIDEI.

SUBORDO I.—AMIADÆ.

SUBORDO II.—LEPIDOSTEIDÆ.

SUBORDO III.—CROSSOPTERYGIDÆ.

Fam. 1.—POLYPTERINI.

Dorsal fin very long, multifid; scales rhomboidal.
Polypterus.

Fam. 2.—SAURODIPTERINI.

Dorsal fins two; scales rhomboidal, smooth; fins subacutely lobate.
Diplopterus, *Osteolepis*, *Megalichthys*.

Fam. 3.—GLYPTODIPTERINI.

Dorsal fins two; scales rhomboidal or cycloidal, sculptured; pectoral fins acutely lobate; dentition dendrodont.

Sub-fam. A. with rhomboidal scales.
Glyptolæmus, *Glyptopomus*, *Gyroptychius*.

Sub-fam. B. with cycloidal scales.
Holoptychius, *Glyptolepis*, *Platygnathus* [*Rhizodus*, *Dendrodus*, *Cricodus*, *Lamnodus*].

Fam. 4.—Ctenododipterini.

Dorsal fins two; scales cycloidal; pectorals and ventrals acutely lobate; dentition ctenodont.

Dipterus, [*Ceratodus? Tristichopterus?*].

Fam. 5.—Phaneropleurini.

Dorsal fin single, very long, not subdivided, supported by many interspinous bones; scales thin, cycloidal; teeth conical; ventral fins very long, acutely lobate.

Phaneropleuron.

Fam. 6.—Cœlacanthini.

Dorsal fins two, each supported by a single interspinous bone; scales cycloidal; paired fins obtusely lobate; air bladder ossified.

Cœlacanthus, Undina, Macropoma.

Subordo IV.—Chondrosteidæ.

Subordo V.—Acanthodidæ.

Considering the Ganoidei, as defined by Müller, to form an order of the class *Pisces*, and adopting the four groups typified by *Amia*, *Lepidosteus*, *Accipenser* and *Acanthodes*, respectively, as suborders, without thereby prejudicing the question as to whether other suborders may not be required, I propose to establish another and equivalent group, or suborder, to comprise the existing *Polypterus* and all those extinct Ganoids which, like it, fall within the range of the following definition:—

Dorsal fins two, or, if single, multifid or very long; the pectoral and usually the ventral fins, lobate; no branchiostegal rays, but two principal, with sometimes lateral and median, jugular plates, situated between the rami of the mandible; caudal fin diphycercal, or heterocercal; scales cycloid or rhomboid, smooth or sculptured.

On the suborder thus defined I propose to confer the title of Crossopterygidæ,* in consideration of the peculiar manner in which the fin rays of the paired fins are arranged, so as to form a fringe round a central lobe, which constitutes so marked a character of all the genera belonging to the group at present known.

The characters of five of the six families which compose this suborder have been given, incidentally, in the preceding pages, but the table contains another family whose collocation with the rest requires justification.

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* κροσσωτὸς, πτέρυξ, "fringed fin." "Crossotopterygidæ" would perhaps be more correct, but the shorter compound is preferable.

This is the family of the PHANEROPLEURINI, which I have established to contain the singular genus *Phaneropleuron*, described at length in this Decade (p. 47) and figured in Plate III. The general character of this fish, its thin cycloid scales, the mode of termination of its caudal extremity, and its remarkable, very acutely lobate, ventral fins, lead me to entertain very little doubt that its right place is among the Crossopterygidæ, and in the neighbourhood of the Glyptodipterini and Cœlacanthini, though I have not yet been able to obtain a very good view of its jugular plates. But the very long, single, dorsal fin, the great length and acute lobation of the ventral fins, which seem to have been longer than the pectorals, and the complete ossification of the costal elements and neural arches throughout the vertebral column, separate *Phaneropleuron* alike from the Glyptodipterini and the Cœlacanthini. From the Ctenododipterini it is separated not only by these characters, but by its dentition. Under these circumstances the only course seems to be to regard it as the type of a distinct family.

The group of Crossopterygidæ, as thus established, appears to me to have many remarkable and interesting zoological and palæontological relations. Of the six families which compose it, four are not only Palæozoic, but are, some exclusively and all chiefly, confined to rocks of Devonian age,—an epoch in which, so far as our present knowledge goes, no fish belonging to the suborders of the Amiadæ or Lepidosteidæ (unless *Cheirolepis* be one of the latter) makes its appearance. Rapidly diminishing in number, the Crossopterygidæ seem to have had several representatives during the Carboniferous epoch, but after this period (unless *Ceratodus* be a Ctenododipterine) they are continued through the Mesozoic age only by a thin, though continuous, line of Cœlacanthini, and terminate, at the present day, in the two or three known species of the single genus *Polypterus*. *Polypterus*, however, is clearly related to the rhombiferous Crossopterygians, or in other words, to exactly that group of whose existence we have no knowledge in any Mesozoic, or Tertiary, formation; while the Ctenododipterini and Cœlacanthini, which depart most widely from *Polypterus*, are those which continue the line of the Crossopterygidæ from the Palæozoic to the end of the Mesozoic epoch. Thus both ends of the Crossopterygian series appear, if I may use the expression, to be cut off from the modern representatives of the suborder; *Polypterus* being separated from those members of its suborder with which it has the closest zoological relations, by a prodigious gulf of time, and from the fossil allies which are nearest to it in time, by deficient zoological affinity. I may make my meaning more intelligible by a diagram, however.

PALÆOZOIC.
Ctenododipterini, Phaneropleurini, Glyptodipterini, Saurodipterini, Cœlacanthini.
MESOZOIC.
Cœlacanthini.
TERTIARY.
RECENT.
Polypterini.

Here it is obvious that, in time, the Polypterini are twice as remote from their immediate zoological affines, the Saurodipterini and Glyptodipterini, as they are from their more distant connexions, the Cœlacanthini.

It seems singular that while the line of the rhombiferous Crossopterygidæ has so distinct a modern representative, the cycliferous Crossopterygidæ seem to have died and left no issue at the end of the Tertiary epoch. But without wishing to lay too much stress upon the fact, I may draw attention to the many and singular relations which obtain between that wonderful and apparently isolated fish, *Lepidosiren*, sole member of its order, and the cycloid Glyptodipterine, Ctenododipterine, Phaneropleurine, and Cœlacanth Crossopterygidæ. *Lepidosiren* is, in fact, the only existing fish whose pectoral and ventral members have a structure analogous to that of the acutely lobate, paired fins of *Holoptychius*, of *Dipterus*, or of *Phaneropleuron*, though the fin rays and surface scales are still less developed in the modern than in the ancient fish. The endoskeleton of *Lepidosiren*, again, is, as nearly as possible, in the same condition as that of *Phaneropleuron*, and is more nearly similar to the skeleton of the Cœlacanths than that of any other recent fish; while, perhaps, it is not stretching the search for analogies too far to discover in the

FIG. 18.

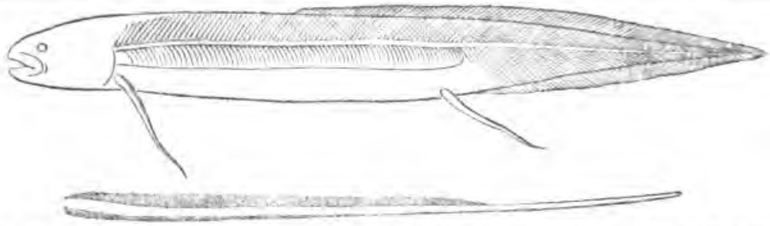

Diagram of *Lepidosiren*. (The lower figure represents the pectoral fin on a larger scale.)

stiff-walled lungs of *Lepidosiren*, a structure more nearly representing the ossified air bladder of the Cœlacanths than any with which we are at present acquainted, among recent or fossil fishes. Furthermore, *Lepidosiren* is the only fish whose teeth are comparable in form and arrangement to those of *Dipterus*.* Though *Lepidosiren* may not be included among the Crossopterygidæ, nor even in the order of the Ganoidei, the relations just pointed out are not the less distinct; and, perhaps, they gain in interest when we reflect, that while *Polypterus*, the modern representative of the rhombiferous Crossopterygidæ, is that fish which has the most completely lung-like of all air bladders, *Lepidosiren*, which has been just shown to be, if not the modern representative of the cycliferous Crossopterygidæ, yet their "next of kin," is the only fish which is provided with true lungs. These are unquestionable facts. I leave their bearing upon the great problems of zoological theory to be developed by every one for himself.

The preceding discussion of the affinities of the Devonian genera, *Osteolepis, Diplopterus, Glyptolæmus, Glyptopomus, Gyroptychius, Holoptychius, Glyptolepis, Dendrodus, Phaneropleuron, Dipterus*, was an indispensable preliminary to the consideration of the main question with which I proposed to deal in the present essay, viz., What, and how many, groups of fishes are represented in the Fauna of the Devonian epoch? a Fauna which presents a surpassing interest, when we recollect that it comprises the oldest assemblage of vertebrate animals, of which we possess a more than fragmentary knowledge; that its constituents abound in certain localities; and that, for many years past, they have been the subject of careful and repeated collection and investigation. An examination of the data collected up to the present time has led me to the following conclusions, some of which are already current, while others are new:—

1. No vertebrate animal higher in the scale than fishes is as yet certainly known to have been found in any rock of Devonian age. In fact, until demonstrative stratigraphical evidence of the Devonian age of the well-known Elgin beds is obtained, the bearing of the palæontological evidence against that conclusion is too strong to allow of its being entertained.

2. Of the six orders of the class Pisces, three, namely, the DIPNOI, MARSIPOBRANCHII, and PHARYNGOBRANCHII, are certainly not represented by any known Devonian fish. In endeavouring to estimate the value of this negative fact, we must recollect that no fish

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* Prof. Pander has drawn attention to the resemblance of the teeth of his genus *Holodus* to those of *Lepidosiren*, but it is not clear that he regards *Holodus* as a Ctenododipterine.

belonging to either of these orders is at present known in the fossil state; that they are represented by a very small number of genera and species in our existing Fauna; finally, that the Pharyngobranchii, from their very nature, could hardly be preserved in a recognizable state, even in such fine mud as that of the Oxford clay, or the Solenhofen slates; and that of the Marsipobranchii nothing but the horny teeth could be expected to escape destruction. *Lepidosiren,* on the other hand, might have left as definite traces of its existence as *Dipterus,* and hence its entire absence in the fossil state is a negative fact of greater value.

3. The ELASMOBRANCHII abounded, teeth and spines testifying to the numerous and diverse genera which haunted the Devonian seas. It is more difficult to say to what sections of the order these genera belonged, as the only Devonian Elasmobranch whose whole structure can be restored with any certainty is *Pleuracanthus,* a fish which belongs to a family distinct from any now living.

4. The GANOIDEI, as I have endeavoured to show above, are largely represented by a suborder, the Crossopterygidæ, which drops into comparative insignificance in later ages. Of the existence of Amiadæ there is no evidence, and even if we include *Tharsis, Thrissops,* and *Leptolepis* under this suborder, they are scanty in all later formations; but what is much more remarkable is the apparent, entire, or almost entire, absence of the Lepidosteidæ, a suborder which obtains such a prodigious development in the Mesozoic epoch. The nature of the Acanthodidæ, and the question whether there is any reason to suspect the existence of Chondrostei during the Devonian epoch will be considered by-and-bye.[*]

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[*] The determination of the characters of the families of Lepidosteidæ and of the limits of the suborder is a difficult problem, of which I hope to treat more fully hereafter. One interesting fact results from my investigations, so far as they have hitherto gone, viz., that *Lepidosteus* belongs to a totally distinct family from its Mesozoic allies, whether "Sauroids" or "Lepidoids." The Pycnodonts and Hoplopleuridæ do not appear to me to belong to the Lepidosteidæ, and I doubt their being true Ganoids. For the present I propose the following as a sketch of an arrangement of the Lepidosteidæ.

LEPIDOSTEIDÆ.
Heterocercal Ganoids with rhomboidal scales; branchiostegal rays; non-lobate paired fins; a preoperculum and an interoperculum.
Fam. 1. Lepidosteini.
Maxilla divided into many pieces; branchiostegal rays few and not enamelled.
Lepidosteus.
Fam. 2. Lepidotini.
Maxilla in one piece; branchiostegal rays many and enamelled; the anterior ones taking the form of broad plates.
(a) *Œchmodus, Tetragonolepis, Dapedius, Lepidotus, &c.*
(b) *Eugnathus, Pachycormus, Oxygnathus, &c.*
(c) *Aspidorhynchus.*
Perhaps the genera marked a, b, c, should form distinct sub-families.

5. Thè TELEOSTEI have hitherto been supposed to be entirely absent from formations of Palæozoic age, and no doubt they do not exist under those forms which are most familiar to ichthyologists acquainted with marine fishes, or with the fresh-water fishes of temperate climates; but, nevertheless, I shall now endeavour to show that there are grounds for something more than a suspension of judgment, as to the validity of the ordinary doctrines held upon this subject.

The remarkable genera *Coccosteus* and *Pterichthys* are those which, among all Devonian fishes, have been by common consent regarded as the most heteroclite and anomalous, some writers having gone so far, in fact, as to imagine that these hard cased vertebrates offered us a transition to the shelled Invertebrata.

Nevertheless, I trust I shall be able to show that the one of these two closely allied genera—*Coccosteus*—is best, indeed, I may say only, to be understood, by comparing its bony shields with those which cover the roof of the cranium and the anterior part of the body of certain existing Siluroid Teleosteans.

To this end, however, I must first give the conception of the structure of *Coccosteus* which my own investigations, guided by those of my predecessors Agassiz, Miller, Egerton, and Pander,* have led me to form.

The superior wall of the skull only, seems to have been ossified in this fish, and forms a great shield, which may be roughly said to have a hexagonal figure. The posterior and postero-lateral sides of the hexagon are pretty nearly straight lines, while the anterior side is rounded off, to form the snout, and the antero-lateral sides, the longest of all, have their anterior moieties deeply excavated, to constitute the upper part of the walls of the orbit. From before backwards, in the median line, the contour of the cranial shield is nearly straight, but from side to side it is convex, in consequence, more particularly, of the, downward inflexion of its postero-lateral angles. The sutures, which separate the various constituent bones of the skull, may readily be confounded with certain superficial grooves of a totally different import, but, by grinding away the outermost layer of bone, this source of error is avoided; and it is then seen that the cranial sutures have the arrangement represented in the woodcut, fig. 19, and define the several bones from one another with great sharpness.

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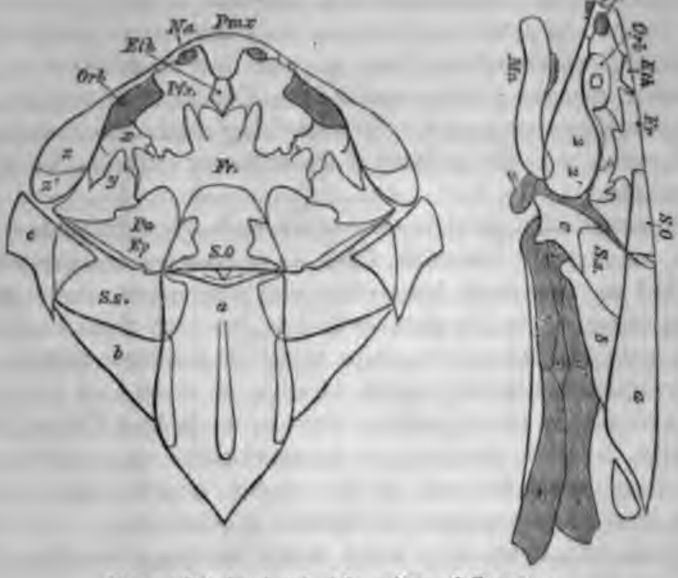
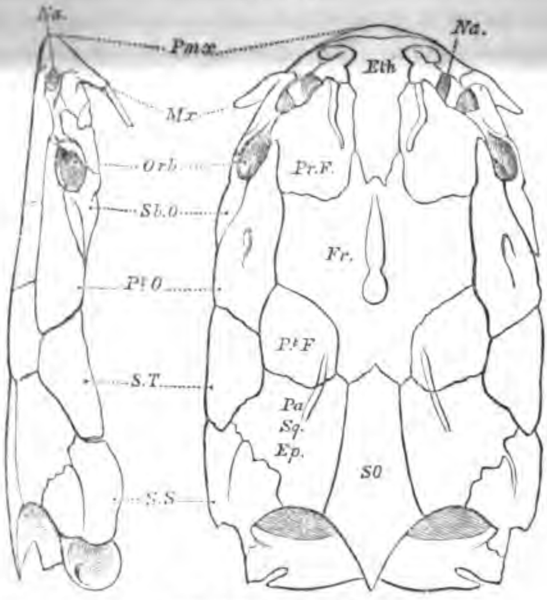
* Compare Agassiz, "Monog: des Poissons Fossiles du Vieux Grès Rouge;" H. Miller, "Old Red Sandstone" and Quart. Jour. Geol. Soc. 1859; Pander, "Ueber die Placodermen des Devonischen Systems, 1857;" Sir P. Egerton, "Remarks on the Nomenclature of the Devonian Fishes," Quart. Jour. Geol. Soc. 1859.

FIG. 19.



Bones of the head and of the cuirass of *Coccosteus*.

FIG. 20.



Bones of the head of *Clarias*.

In the middle line, behind, they mark off a symmetrical, trapezoidal bone, S.O., which presents a short peg-like process in the middle of its posterior edge, and has a peculiar raised pattern upon its under surface. In front, this bone is articulated with the singular four-rayed bone Fr. The posterior ray (with which S.O. is connected) is the shortest and broadest of the four, while the lateral rays are the longest and the narrowest, the anterior ray holding a middle position in this respect. The edges of the anterior and of the lateral rays are variously indented, apparently to form an interlocking suture with the adjacent bones, while the posterior ray is deeply excavated to unite with S.O. A third bone, much smaller than the preceding, succeeds them anteriorly, and appears to be separated by a transverse suture from a fourth median bone (Pmx.), whose rounded free edge forms the anterior contour of the snout. In well-preserved specimens, this edge is seen to be beset with small, projecting, spine-like tubercles or teeth. The lateral portions of the skull are constituted, proceeding as before, from behind forwards, as follows: a triangular bone (Pa. Ep.), one of whose sides, directed outwards and backwards, forms the postero-lateral side of the hexagon above referred to, unites, by its inner edge, with the bone S.O., and, by its anterior edge, partly with Fr. and partly with another bone (*y*). These edges are irregularly sinuous, and form a squamous suture with the neighbouring bones. The posterior edge of Pa. Ep. presents, near its inner extremity, a sort of socket, with which a peg developed from the plate S.s. is articulated.

An irregularly triangular bone (*y*) is connected with the anterior edge of Pa. Ep., and forms the posterior angle and part of the antero-lateral edge of the skull. It is succeeded by another irregular bone (*x*), which enters into the posterior and upper wall of the orbit, and unites internally with Fr., and anteriorly with a larger and still more irregular bone Pfr. The latter is connected internally with Fr., Eth. and Pmx.; while externally it sends off, rather in front of the middle of its length, a short process, which passes directly downwards and divides the orbital cavity (Orb.) from the nasal cavity (Na.) Extending from the lower end of this process to the postero-lateral angle of the skull, bounding the orbit below, and fitting in by its convex margin, to a concave excavation of the bones *x*, *y*, is a large spatulate bony plate, narrow in front, broad and expanded behind, and composed of two pieces, *z* and *z'*.

The cranio-facial shield thus composed is succeeded by an osseous girdle, which defended the anterior part of the body like the back and breastplates of a mediæval warrior, and is divisible into two portions, the dorso-lateral and the ventral shields—the former composed of nine pieces, the latter of six. Of the nine pieces of the dorso-lateral shield, seven are closely articulated together, while the other two, small and comparatively insignificant, (and not represented in the dorsal view, fig. 19) were placed loosely at the sides of the posterior end of the great median plate of the seven. This plate *a* corresponds in width, anteriorly, with the cranial bone S.O.; it widens a little behind the middle of its length, and then rapidly tapers to a point. From the middle of its under surface it sends down a strong bony crest, deeper behind than in front, while its lateral edges overlap and unite, by a squamous suture, with the plates S.s. and *b*.

S.s. is a four-sided plate, articulated with Pa. Ep. in the manner before mentioned, while behind it overlaps the triangular plate *b*, and below is overlapped by the plate *c*. The latter is so constantly thrown out of its place in specimens where the connexion between *a*, *b* and S.s. is perfectly retained, that I suspect it rather overlapped than was suturally united with S.s.

The ventral shield appears to me to have had no direct connexion with the dorsal. I have examined a large number of specimens with reference to this point, but I have never discovered the least evidence of a sutural union between any two elements of the two shields, though the respective constituents of each shield are constantly met with in all stages of union and disunion. Of the elements of the ventral shield, two are median and symmetrical, four lateral and in pairs. The two latter, upon each side, are broad at their remote ends and narrower at their adjacent ends, whose outer edges are, besides, somewhat bent up. Of the median plates, the posterior is rhomboidal and articulates with all the others; the anterior has the form of an elongated isosceles triangle, whose base, directed anteriorly, is rounded off and forms the middle of the anterior margin of the ventral shield.

The stout, doubly curved, clavicle-like bones Mn., found, in complete specimens, on the under side of the head, have one edge beset with minute denticles for a short distance; and there are two other flat, elongated, bones, devoid of sculpture upon their outer surfaces, which lie between them and the anterior edge of the ventral shield.

Beside the parts now described, the only other bones known to belong to *Coccosteus* are the neural and subcaudal arches, the fin-rays and their supports, and the curved ossicles which lie just behind the body armour, and were perhaps connected with ventral fins; but I enter into no particular description of these, as they are not essential to my present purpose.

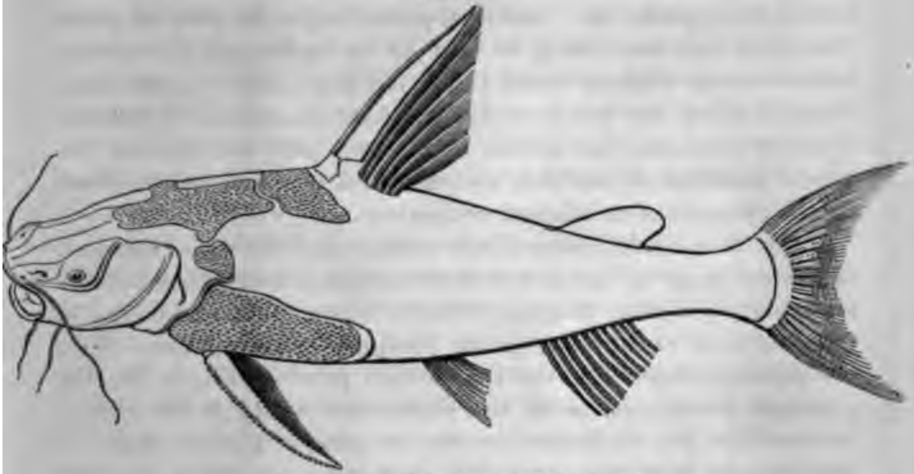
For some years past I had suspected that the modern Siluroids presented more analogies to the seemingly aberrant Devonian fishes than any other members of the class Pisces, and from the examination of dried specimens, I had even pitched upon the Siluroid genus *Clarias* as that most likely to help me to understand *Coccosteus;* but it was not until my friend and former pupil, Mr. J. J. Monteiro, brought home for me from Congo some specimens of *Clarias capensis* preserved in spirits, that I was able to examine the osseous structure of that fish with sufficient care and thoroughness for the purposes of an efficient comparison.

In fig. 20 a careful, reduced representation of the top of the skull of this fish is given, and it will be seen, that in everything but the minor details of form, it agrees with *Coccosteus.* The middle line of the skull is, as in the latter genus, occupied by three bones. S.O., the supra-occipital, is, in the recent form, pointed behind; Fr., the principal frontal, is, as in the fossil, four-rayed; it exhibits a considerable gap or fontanelle, but no median suture; Eth., the ethmoid, and Pmx., the premaxilla, correspond exactly in the two skulls, if we leave out of consideration the position of the suture seen in the fossil in this region. The bone Pr. F., which can be at once identified as the prefrontal in *Clarias,* and which sends down a process dividing the orbit from the nostril, obviously corresponds with the similarly related bone in *Coccosteus;* while in *Clarias* the orbit is completed below by the spatulate suborbital bone, Sb. O., smaller in proportion and undivided, but otherwise similar to the bone *z, z'* of *Coccosteus.* The post-orbital bone, Pt. O., and the supra-temporal bone, S. T., of the former appear to have their homologues in the bones *x* and *y* of the latter fish.

The space between the frontal, the supra-occipital, and the supra-temporal is occupied, in *Clarias,* by two bones, the anterior of which certainly represents the post-frontal; while the posterior occupies the situation of no less than three distinct bones in the heads of ordinary fishes, viz., the parietal, the squamosal, and the epiotic. The reduction in the normal number of bones which obtains in the Siluroid has been carried a step further in *Coccosteus,* where the plate lettered for shortness' sake only Pa. Ep. is the only representative of the bones Pt. F. and Pa. Sq. Ep. of *Clarias.*

Lastly, comes the bone S.s. naturally united in *Clarias* to Pa. Sq. Ep. and to S. T., and which corresponds with the supra-scapula of ordinary osseous fishes, in which it is usually connected with the skull only by ligament. The Siluroids and Ganoids, however, coincide in always having this bone more closely united with the regular cranial bones, and *Coccosteus*, it will be observed, agrees with them.

FIG. 20.

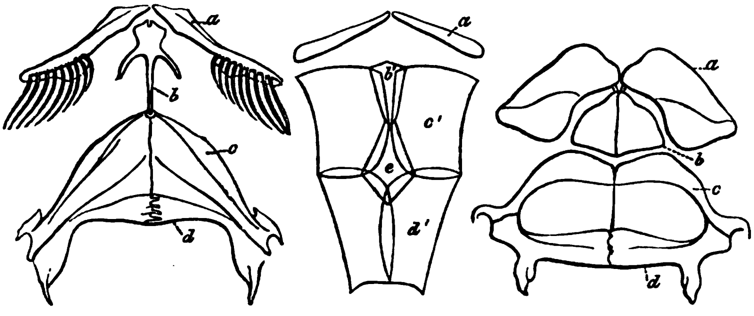


Arius rita, after Cuvier and Valenciennes.

So much for the cranial shield. To comprehend the dorsal and ventral body shields we must have recourse, not to *Clarias*, but to other Siluroids, such as *Bagrus*, *Arius*, &c. In these fishes, in fact, the anterior dorsal interspinous bones become so modified as to form a great shield-shaped dermal plate, with a strong inferior crest, which occupies the same position and has the same relations as the medio-dorsal plate of *Coccosteus*, though it commonly bears a strongly articulated spine, which is absent in the latter genus. In some species, as *Arius cruciger*, the principal plate is provided with lateral accessory plates, in which, perhaps, we have the homologues of the dermal plates *b*, of *Coccosteus*. It is possible that *c* may have been the operculum, which occupies a nearly similar position in *Arius*, but if it were suturally connected with the suprascapula, this view would be untenable, and the bone would have to be regarded as a scapular element.

In the Siluroids to which I have referred, and in *Loricaria*, a vast latero-ventral shield is produced by the prodigious expansion and coalescence of the bony elements which are homologous with those termed "coracoid" and "radius" in other fishes. Viewed from the ventral surface, these bones form four great plates, those of each side being closely united, or even amalgamated together, while the opposite pairs are joined, in the middle line, by a strongly serrated suture.

FIG. 21.



Hyoidean and Pectoral Plates of
Clarias. *Coccosteus.* *Loricaria.*

When the pectoral fin is provided with an anterior spine, this is articulated by a curiously complicated joint with the so-called coracoid. The cornua of the hyoid are large stout bones, and the urohyal, also a large and strong bone, which is particularly broad in *Loricaria*, connects the hyoidean with the pectoral apparatus.

On comparing this apparatus with the sternal shield of *Coccosteus*, one is tempted to compare the antero-median piece of the latter with the urohyal of the Siluroid, the antero-lateral piece with the "coracoid," and the postero-lateral piece with the so-called "radius," the more especially as the antero-lateral piece corresponds with that part of the thoracic shield of *Pterichthys* which supports the plated appendage representing the pectoral fin, in that genus.

On the other hand, it must be confessed that the closer connexion of the antero-median piece with the thoracic plates than with the hyoidean cornua, and the very backward position of the postero-lateral plates, apparently out of reach of any connexion with the fins, militate against this view; which, in addition, leaves the median rhomboidal plate unaccounted for.

The bones Mn. are, of course, as has long been determined, the rami of the mandibles of *Coccosteus*. Their singular figure is not unlike that of the corresponding bones in *Loricaria*. Finally, the long flat bones *a* (fig. 21), I have no doubt, are the chief parts of the hyoidean arch, which are also proportionately large in many Siluroids.

No one, I think, will deny that the structural coincidences here detailed are of very great weight, and that in the absence of contrary evidence they must lead us to assign a place near, if not among, the Siluroidei to *Coccosteus*. I do not know that any facts which can be adduced can be fitly considered as such directly contrary evidence, but there are several difficulties which require careful consideration.

In the first place, *Coccosteus* seems to have possessed neither basal nor lateral cranial bones,—at least, no traces of such structures have yet been discovered; so that, in all probability, this fish possessed a cartilaginous primordial cranium like that of *Accipenser*; and, indeed, a still more gristly one, for *Accipenser* has a large basal ossification. The hyomandibular suspensory apparatus must have been equally cartilaginous, and, in the vertebral column, only the superior and inferior arches were ossified. Assuredly this is very unlike what we are accustomed to see among the Teleostei, but it must be recollected that it is at least equally unlike what we find in the Ganoids, if we except those of the same epoch; and, on the other hand, there are some recent Teleostei, though there are no known Ganoidei, whose vertebral columns and skulls exhibit a correspondingly low stage of organization.*

In the second place, arises the question whether, since we know that a true Ganoid, *Amia*, completely simulates the outward form of a Clupeoid Teleostean, while retaining all the essentials of its order,—may not *Coccosteus* be also a true Ganoid which simulates the outward aspect of a Siluroid? To this question it is, perhaps impossible to give any answer, save by asking another, viz.:—Why should not a few Teleosteans have represented their order among the predominant Ganoids of the Devonian epoch, just as a few Ganoids remain among the predominant Teleosteans of the present day? When it is considered that an ichothyologist might be acquainted with every fresh-water and marine fish of Europe, Asia, Southern Africa, Southern America, the Indian Archipelago, Polynesia, and Australia, and yet know of only one Ganoid, the Sturgeon, a fish so unlike the majority of its congeners, that a naturalist might be well acquainted with almost all the fossil Ganoids, and yet not recognize a sturgeon as a member of the group,—it will not seem difficult to admit the existence of a Teleostean among the Devonian Ganoids, even though that Teleostean should in some, even important, points differ from those with which we are familiar.

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* See on this point, however, the remarks at p. 38, under (3).

At any rate, I think the *primâ facie* case in favour of the Teleostean nature of *Coccosteus* is so strong, that it can no longer be justifiable to rank it among the Ganoids, "*sans phrase*," but that even those who will not allow it to be Teleostean must attach to it the warning adjunct of *incertæ sedis.*

No one doubts that wherever *Coccosteus* goes, *Pterichthys* must follow, and though the structure of the last-named fish is, in some respects, more difficult of interpretation than that of the former, in others it is strikingly Siluroid. For example, I know of no piscine structure that is even remotely comparable to the proximal joint of the pectoral limb of *Pterichthys*, except the corresponding articulation of the pectoral spine and fin of the Siluroids. And again the example of *Ostracion* shows that the box-like cincture of the body of *Pterichthys* is by no means foreign to the Teleostean group, though it cannot be paralleled by fishes of any other order. Whether the other "Placodermi" of Pander, such as *Asterolepis* (Ag. and Miller) really belong to the same group as *Coccosteus* and *Pterichthys*, or not, is a question which can perhaps be hardly settled at present; although, provisionally, I am much inclined to associate them together. In principle, the cranial structure of *Asterolepis*, is very similar to that of *Coccosteus.*

Having disposed of the undoubted Elasmobranchs, of the Crossopterygian Ganoids, and of the "Placodermi" of the Devonian epoch, several important and rather difficult groups remain for discussion. These are the Acanthodidæ, the genera *Cephalaspis* and *Pteraspis*, and the genus *Cheirolepis.*

The ACANTHODIDÆ have hitherto been ranked among the Ganoids, but the following considerations have often led me strongly to suspect that they might be Elasmobranchs:—

1. Their dorsal spines are similar in form and mode of implantation to those of the Elasmobranchii, except perhaps that the surface of the implanted portion is less different from the rest than in the latter order.

2. Their dermal ossicles are more like shagreen than scales.

3. As Roemer has pointed out, their lateral line runs between two rows of these ossicles, and is not formed by separate canals or grooves in successive scales as in most Ganoids and Teleosteans.

4. They seem to have had no distinctly ossified cranial bones.

5. They have no opercular apparatus, but as Sir Philip Egerton long ago pointed out to me, their branchial arches are naked.

6. The sternal part of their pectoral arch seems to have had no bony connexion with the head.

On the other hand, however, it must be considered that,—

1. The Acanthodidæ, unlike all Elasmobranchs, have great spines articulated with the pectoral arch.

2. The dermal plates of the Ganoid *Cheirolepis* are very shagreen-like, though affirmed by Pander to differ in structure from those of Acanthodidæ.

3. The cranial bones become less and less developed in the Chondrosteous Ganoids, until in *Spatularia* they are very thin squamose lamellæ; so that there is no great difficulty in the way of supposing their entire absence in a true Ganoid.

4. In the same way, the opercular apparatus, small in *Accipenser*, is still more reduced in *Spatularia*.

5. The thin, curved, toothless mandibles of *Spatularia* present, perhaps, the nearest analogue to the singular mandibular bones of *Acanthodes*.

6. As Roemer has pointed out, *Paleoniscus* has orbital plates very like those of *Acanthodes*.

7. The production of the pectoral arch into long backwardly directed processes in *Diplacanthus* and *Cheiracanthus* is the very reverse of an Elasmobranch character, seeing that the like only obtains, so far as I know, in some Siluroids.

8. *Acanthodes* is provided with two very long filaments, beset with short lateral branches, which proceed from the region of the mouth, and such oral tentacles are to be found only in Ganoids and Siluroids.

Under these circumstances the safest course probably is to regard the Acanthodidæ as a distinct suborder of Ganoids.

The genera *Cephalaspis*, *Pteraspis*, *Auchenaspis*, and *Menaspis* certainly form a family by themselves, to which the title of CEPHALASPIDÆ may be conveniently applied; but the position of this family is not readily determinable. No one can overlook the curious points of resemblance between the Siluroids, *Callichthys* and *Loricaria*, on the one hand, and *Cephalaspis*, on the other, while in other respects, they may be still better understood by the help of the Chondrostean Ganoids. Compare, for example, *Scapirhynchus* with *Cephalaspis*, or the great snout of *Pteraspis* with that of *Spatularia*. I am inclined to place the Cephalaspids provisionally among the Chondrostei, where they will form a very distinct family.

The affinities of two genera remain for discussion, the one being the well-known *Cheirolepis* of Agassiz, the other, the new genus

Tristichopterus, described by Sir Philip Egerton in the course of the following Decade.

Cheirolepis contains fishes with moderate-sized heads and markedly heterocercal tails; with a single dorsal fin, a single anal, pectorals, and ventrals. The median fins are situated forwardly, the dorsal being over the posterior part of the anal; and the ventral fins are so forward as to be almost close to the pectorals. None of these fins are lobate. The body is covered with minute rhomboidal scales, which do not overlap one another, so that the skin has quite the aspect of shagreen. Nevertheless, according to Pander, the structure of these bony scales is not so like that found in the Squalidæ as that of the scales of *Diplacanthus*.

The head is usually crushed, and its component elements displaced, but according to Professor Pander, whose account is largely borne out by the specimens I have examined, the middle of the roof of the cranium, from the posterior edge of the occiput to the anterior edge of the frontal region, is covered by two broad bony plates, which were, perhaps, divided in the middle line. Pander considers the anterior of these to be frontals, the posterior, to be parietals. At the sides of the parietals lie three narrow bones, which, perhaps, all belong to the skull, though the inner and uppermost may appertain to the shoulder girdle. The anterior edges of the other two bound the orbit posteriorly, and similarly elongated plates lie in front of the eyes, beside the frontals. The upper jaw is a large bone, rounded off posteriorly and tolerably broad behind, while anteriorly its upper edge suddenly becomes excavated to form the lower boundary of the orbit and then tapers off; it is beset with small sharp conical teeth. The gape extends very far back, and the lower jaw is a long flat bone toothed like the upper.

According to Agassiz, there were larger teeth interspersed among the smaller ones ("Recherches," p. 130; "Vieux Grès Rouge," p. 44), but all in a single row. Like Pander (l. c., p. 73), I have been unable to discover these larger teeth. The opercular apparatus and the branchiostegal rays, or their representatives, were not observed by Pander, nor have I seen indubitable evidence of their characters; but Agassiz (" Recherches," p. 132) has described and figured the branchiostegal rays of *Ch. Uragus*. " The branchiostegal rays " are very well preserved on both sides of the head; the anterior are " shorter and larger; they are well seen on the left side. The " posterior ones, which are better preserved on the right side, are " narrower and more elongated. I count at least ten of them."

According to Pander a large perforated plate surrounds the eye.

Miller, Giebel, and Pander have agreed upon the propriety of separating *Cheirolepis* from the other Acanthodidæ of Agassiz, and Pander proposed to form for it a distinct family, that of the CHEIROLEPINI. Granting, as I think every one must do, the justice of this step, the question next arises in what suborder of the Ganoids does this family arrange itself.

It certainly is not one of the Crossopterygidæ, for it has but a single, comparatively short, dorsal fin, neither pectorals nor ventrals are lobate, and there are no jugular plates ; still less can *Cheirolepis* be ranked among the Amiadæ or Chondrosteidæ. On the other hand, it presents certain points of resemblance with *Paleoniscus*, and through those forms connects itself with that large body of fossil fishes which have more or less direct relations with *Lepidosteus*. Perhaps then, *Cheirolepis* ought to be regarded as the earliest known form of the great suborder of the Lepidosteidæ.

In the absence of a full knowledge of the head, of the paired fins and of the dentition, it would be hazardous to form any decided opinion as to the affinities of *Tristichopterus ;* I strongly suspect, however, that it will turn out to be the type of a new family allied to the Ctenododipterini and Cœlacanthini.

The cranio-facial bones are lettered as follows in the woodcuts :—

S. O.	Supra-occipital.
Fr.	Frontal.
Eth.	Ethmoid.
Ep.	Epiotic.
Pa.	Parietal.
Sq.	Squamosal.
Pt. F.	Post-frontal.
Pr. F.	Pre-frontal.
S. T.	Supra-temporal.
Pt. O.	Post-orbital.
Sb. O.	Sub-orbital.
Mx.	Maxilla.
Pmx.	Premaxilla.
H. M.	Hyomandibular bone.
Qu.	Os quadratum.
S. S.	Supra-scapular.
Op.	Operculum.
S. Op.	Sub-operculum.
Ju.	Jugular bones.
Sp. O.	Spiracular ossicles.
St. O.	Supra-temporal ossicles.

P.O. " Pre-operculum " occurs in the woodcut, fig. 2 ; but I am now much inclined to doubt the existence of a true pre-operculum in any Crossopterygian fish.

T. H. HUXLEY.

Jermyn Street, Nov. 1, 1861.

[NOTE.—By the great kindness of Dr. Taylor of Elgin, I have just had the opportunity of examining a beautiful, almost entire, specimen of *Glyptopomus*, with two dorsal, and exquisitely lobate pectoral, fins.—T. H. H., Nov. 18th.]

BRITISH FOSSILS.

DECADE X. PLATES I. AND II.

GLYPTOLÆMUS KINNAIRDI.

[Genus GLYPTOLÆMUS. HUXLEY. (Sub-kingdom Vertebrata. Class Pisces. Order Ganoidei. Suborder Crossopterygidæ. Family Glyptodipterini.) Body elongated, tapering to a point posteriorly. Cranium depressed. Dorsal fins two, distinct, situated in the posterior two-fifths of the length of the body. Ventral fins under the first dorsal, and like the pectorals lobate. The rhomboid scales and the cranial and facial bones ornamented with raised ridges. Teeth of two sizes, composed of (probably) dendrodentine. Tail diphycercal.]

Glyptolæmus Kinnairdi. SP. UNICA.

Specimens of this genus were first described, and their distinctive characters pointed out by me, in a notice inserted in Dr. Anderson's work upon "Dura Den," which was accompanied by excellent, though small, illustrative figures, drawn by Mr. Dinkel.

Since 1859, thanks to Dr. Anderson's zeal and activity, a number of additional specimens, several of great beauty and interest, have passed into the collection of the Museum of Practical Geology, so that I am now in a position to give a tolerably complete account of the structure of these ancient fishes. The singularly beautiful and accurate figures in Plates I. and II. will enable the reader, step by step, to verify for himself the most important points of my description.

The body is, as I have said, elongated, and when viewed sideways, fusiform, tapering to a point at each extremity (Plate I. fig. 1), but when viewed from above or below, though the caudal extremity is still seen to end in a point, the anterior part of the body rapidly widens (Plate I. fig. 3), and ends in a depressed, broad, and shovel-shaped head, with a semi-elliptical contour, rounded at the snout.

The length of the whole body is about four and a half times as great as the distance from the end of the snout to the posterior margin of the opercular apparatus; which distance exceeds by as much as a fourth, or a fifth, the transverse diameter of any part of the body. It somewhat exceeds, again, the perpendicular distance from the upper margin of any part of the dorsal, to the lower margin of any part of the anal fin. The greatest transverse diameter of the head is equal to the distance from the snout to the posterior margin of the parietal bones.

The specimen figured in Plate II. furnishes a very complete view of the structure of the cranium of *Glyptolæmus*, the arrangement of whose constituent elements is still further elucidated by the diagrammatic woodcuts fig. 2 (p. 2 of the "Preliminary Essay") made from enlarged and restored views of the skull and its appendages.

The cranial bones are thin and scale-like, and their surface exhibits numerous long and sinuous ridges, separated by narrow and comparatively deep grooves, which sometimes obscurely radiate from the centre of the bone.

The premaxillary bones, slender and slightly curved, uniting in a broad, but short, ascending internasal process, form the anterior boundary of the snout and limit the nostrils below, joining the equally slender maxillaries which constitute the rest of the upper boundary of the gape behind. The upper and inner edges of the ascending processes of the premaxillaries abut against the anterior margins of a flat hexagonal bone, whose posterior margins unite with the frontals, while its lateral edges are connected with the inner edges of the nasal bones. This bone is therefore obviously the ethmoid.

The frontals, which succeed the ethmoid in the middle line, are short, but comparatively narrow bones, separated by a very distinct suture, which widens in the middle of its length, so as to form a small rhomboidal fontanelle. The posterior edges of the frontals are truncated, and unite with the anterior margins of the parietals, which are almost twice as long as the frontals, and enter more largely than any other bones into the formation of the roof of the skull. The left parietal rather overlaps the right posteriorly, and each parietal suddenly widens in its posterior moiety, so that its outer edge presents a deep notch or step into which the post-frontal fits. The posterior edges of the parietals are as abruptly truncated as the anterior. They unite in the middle line with the apex of the large rhomboidal scale, or bone, which occupies the place of the supra-occipital.

The supero-lateral regions of the skull are formed in front by the large nasals; behind these by the prefrontals, which unite with the maxilla, the nasals and the frontals below, in front and above, and apparently, with the post-frontal behind. Their posterior excavated margins form the anterior boundary of the orbit.

The post-frontals, better defined posteriorly than anteriorly, appear to join the prefrontals, and then, extending backwards beyond the posterior margins of the frontals, they unite with the anterior moiety of the parietals, filling up all that notch in the outer border of these bones, which has been described. Their posterior edges are connected, internally, with the anterior margins of the projecting part of the parietal, externally with the same margins of the small quadrilateral squamosal bones.

The posterior part of the supero-lateral region is completed by two squamiform bones, which take the place of the external occipital, or epiotic, bones of other fishes, filling the interspaces left between the supraoccipital and the opercular apparatus. The inner surface of this bone, on the left side, presents a very well marked triradiate impression, one crus of which is directed transversely inwards, while the others are respectively directed forwards and backwards. A shallow groove upon the surface of the supraoccipital, which has a slight concavity forwards, connects the transverse crus of the impression on one of these bones with that on the other.

The triradiate marks are much more distinct upon the inner surface of these bones, where they form distinct ridges, than upon the outer surfaces, where they appear only as very shallow and indistinct grooves; and, except for the continuation of each transverse crus into its fellow across the supraoccipital, I should have been disposed to connect them rather with the semicircular canals of the auditory organ than with the so-called mucous grooves.

The lateral regions of the skull behind the premaxillaries are formed, in front of the orbit, by the prefrontal and maxillary, and behind the orbit, first, by the maxilla and a large postorbital bone, then by the maxilla, by the bone marked P.O., which may very likely not be a true preoperculum, and a large supratemporal bone. The latter articulates above with the postfrontal and squamosal, and fits posteriorly into the notch formed by the vertical and horizontal portions of the bone P.O.

The operculum, a large four-sided bony plate, is connected with the outer edge of the epiotic above and with the posterior edge of the ascending ramus of the bone P.O. in front. Its lower edge articulates with the upper margin of the suboperculum, which is about half as large as the operculum, and has a much more rounded posterior edge.

The palato-quadrate arcade is best exhibited in fig. 1a, Plate I., though the lines of demarcation between its constituents are not visible. Posteriorly, it is broad and expanded, furnishing the condyle to the mandibles by its outer and lower margin, while its upper and inner part probably abutted against the sphenoid. Anteriorly, it rapidly narrows, and is continued forwards as a strong bony bar. Running parallel with and outside this, is a second elongated bony ridge, which may be distinct from the foregoing, or may be only the outer part of it. At any rate, the two seem to become one in front. Here they support a very strong tooth, and there is a second large tooth situated far back upon the outer bone.

This palato-quadrate apparatus, taken altogether, very much resembles that of *Lepidosteus* in form, and in the large teeth which it bears.

The contour of the stout mandible follows that of the head, the gape extending as far back as the level of the posterior edges of the parietal bones. The rami are very stout, but appear to have consisted of only a thin osseous shell, sculptured externally in the same way as the cranial bones. The constituent elements of the mandible are not distinctly separated from one another in any specimen.

The jugular plates consist of two principal and a number of lateral scale-like bones. The former are elongated, nearly right-angled, triangles, with their perpendiculars turned towards one another, and their apices engaged in the re-entering angle of the rami, while their bases are situated midway between the articular ends of the rami and the posterior margins of the opercular apparatus. The peculiar sculpturing of these plates gave rise to the name of the genus, and is well shown in fig. 1c, Plate II. The outer edges of the principal jugular bones lie close to the inner edges of the rami of the mandible anteriorly, but posteriorly a space is left between them, which gradually widens posteriorly, and is so continued between the suboperculum and the posterior part of the principal jugular plate. This interval is filled up by the secondary jugular plates, of which, in one specimen, I count five, gradually increasing in size from before backwards. All these plates exhibit the characteristic surface ornamentation, and the last, much larger than any of the others, extends beyond the level of the posterior margin of the principal jugular plate, its curved free margin sweeping backwards and outwards, and lying between the suboperculum and the pectoral arch, while a considerable portion of the bone seems to pass under and be overlapped by the suboperculum. There is no median rhomboidal intercalary bone between the anterior and inner edges of the principal jugular bones.

The ventral part of the pectoral arch is represented, on each side, by two broad, triangular, somewhat curved, bones. The anterior one meets its fellow in the middle line, just behind the posterior edges of the principal jugular bones; but their inner margins immediately diverge, passing backwards and outwards, and being continued in the same direction as far as the posterior edge of the operculum, by the inner edge of the posterior pectoral plates. The adjacent margins of the two plates seem to be firmly united together, and their outer surfaces exhibit a marked sculpture, whose ridges are more evenly continuous than those of the cranial bones. Two large triangular scales which fit in between the supraoccipital and the epiotic appear to represent some of the upper elements of the pectoral arch.

The pectoral fins are not perfectly displayed in any specimen, but fig. 2, Plate II., shows that they were well developed, being about as long as the head, and that they were provided with numerous long and delicate fin rays which beset the edges and extremity of a stout central stem, covered with rhomboidal scales.

The ventral fins, smaller than the pectorals, were also, as figs. 2, 3, Plate I., show, distinctly lobate, their central stem being covered with rhomboidal scales and terminating in a point, at about the middle of the length of the fin.

The median fins present very distinct jointed fin-rays, and, as may be seen in fig. 1, Plate I., the scales of the body are continued on to the bases of the dorsals and anal, so as to give them, though to a far less degree, the lobate aspect of the pectorals and ventrals.

Both dorsals are pointed at their extremities, and somewhat fan-shaped, from being narrower at their bases than in their posterior moieties. The first dorsal is smaller than the second. The anal fin, opposite the second dorsal, is about as large as the latter, and has the same slightly lobate aspect.

The rhomboidal caudal fin, whose rays commence almost immediately behind those of the second dorsal and anal, is perfectly symmetrical, the axis of the tapering extremity of the body being not only free from any upward inflexion, but corresponding with the "equator" of the fin.

The scaly extremity of the body appears to stop at some distance before reaching the posterior margin of the fin, but it is difficult to make quite sure of the fact.

The scales are thin, and exhibit a sculpture of variable appearance, but always made up of raised ridges, with intervening valleys and pits over the greater part of their surface; narrow smooth facets being left along two sides to receive the overlapping edges of other scales.

A single longitudinal row of hexagonal scales occupies the middle line of the back, and a less marked row of rhombic scales runs along the ventral median line. The lateral scales, rhomboidal in form, extend from the medio-dorsal to the medio-ventral series, forming curved rows transverse to the axis of the body in general direction, but presenting a marked concavity, or re-entering angle, forwards.

With respect to the dentition of *Glyptolæmus*, I find a series of minute pointed teeth along the outer margins of both upper and lower jaws. Besides these there is a single large tooth upon each side of the symphysis of the mandible, and at least one more of the same kind, a little in front of the middle of the ramus (fig. 1b, Plate II.) In the upper jaw, the pterygopalatine apparatus is, as I have already pointed out, provided with several similar teeth.

Glyptolæmus is at present only known to occur in the Old Red Sandstone of Dura Den.

EXPLANATION OF PLATES I. AND II.

Plate I.

Fig. 1. Side view of a specimen of *Glyptolæmus Kinnairdi*, half the size of nature. This and the other figures of the plate are taken from specimens in the Museum of Practical Geology.

Fig. 1a. Head of the same, natural size.

Fig. 2. Ventral and anal fins of another specimen.

Fig. 3. Ventral view of another specimen, half the natural size. Mus. Pract. Geol

Fig. 4. Scales magnified.

Plate II.

The figures give various views of a specimen of *Glyptolæmus Kinnairdi* in the Museum of Practical Geology, and are all, except 3, 4, and 5, of the natural size.

Fig. 1. Dorsal view of the body.

Fig. 1a. Lateral view of the head.

Fig. 1b. Front view of the head.

Fig. 1c. Ventral view of the body.

Fig. 2. Sandstone matrix into which the body fits, and which retains many of the dorsal scales and the pectoral fins.

Figs. 3, 4, and 5. Scales from different parts of the body magnified.

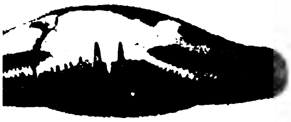
November 1, 1861. T. H. HUXLEY.

DECADE X. PL. 2.

GLYPTOLŒMUS.

(Devonian)

Fig 1^{b}



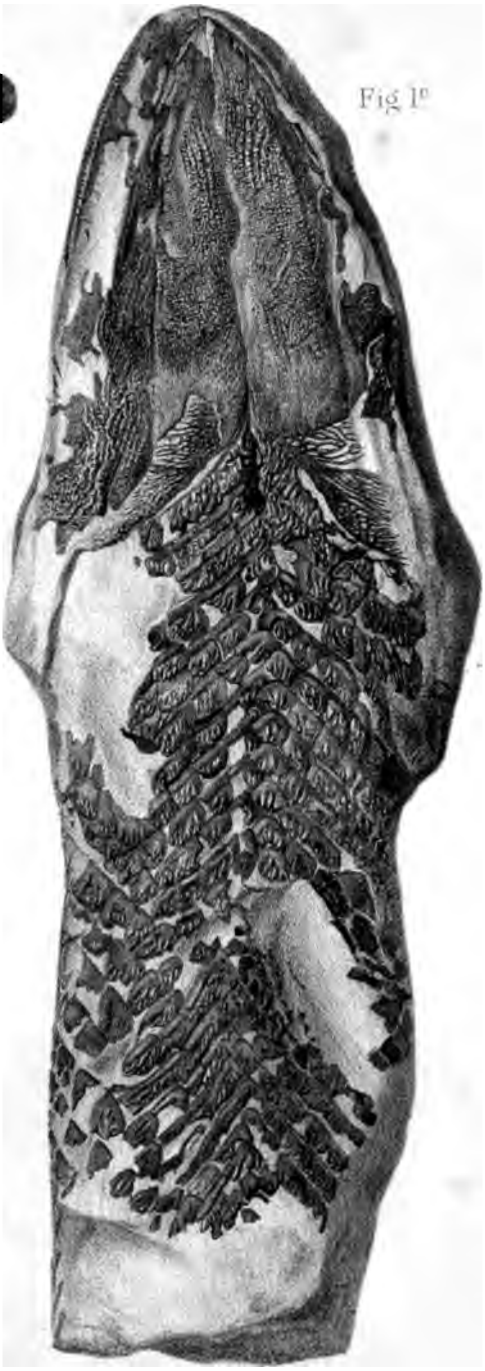
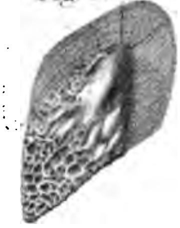


Fig 1^{a}

Fig. 5.



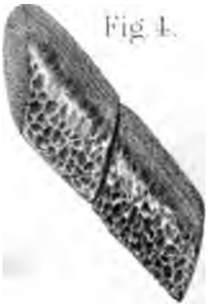


Fig 4.

[illegible] Lith

BRITISH FOSSILS.

DECADE X. PLATE III.

PHANEROPLEURON ANDERSONI.

[Genus PHANEROPLEURON. Huxley. (Sub-kingdom Vertebrata. Class Pisces. Order Ganoidei. Sub-order Crossopterygidæ. Family Phaneropleurini.) Body elongated, tapering to an acute point posteriorly, compressed from side to side. Dorsal fin single, extending for nearly the length of the posterior half of the body; the paired fins acutely lobate; the ventrals very long, apparently longer than the pectorals, and situated beneath the anterior end of the dorsal fin. Tail inæquilobate, the upper lobe being by far the smaller. Scales cycloid, very thin. Teeth numerous and conical. Neural arches, ribs, and interspinous bones well ossified.]

Phaneropleuron Andersoni. Sp. Unica.

All the specimens of this species and genus at present known have been procured from the Old Red Sandstone at Dura Den, associated with *Holoptychius*, the two genera being constantly found associated in the same slabs of sandstone. A fine series of examples is to be seen in the British Museum and the Museum of Practical Geology, the whole of which, I believe, were collected by Dr. Anderson, in whose work upon Dura Den the first description of the present species appeared. The fish had received the name of *Glypticus* from Agassiz long before, but the name was unaccompanied by any description or definition, and has been used for a genus of Echinodermata. The most complete specimen I have seen is that figured (two-thirds of the natural size) in Plate III. fig. 1, which occurs among a number of other examples of this genus and of *Holoptychius*, in a fine slab marked 26120 in the collection of the British Museum.

The length of body equals about 5¼ lengths of the head. It remains of tolerably equal thickness from the pectoral region to that of the ventral fins, and then gradually tapers off to a finely pointed caudal extremity, which is, usually, slightly bent upwards. When the mouth is shut, the head also presents a triangular contour, both its upper and its under outlines rapidly shelving towards the snout.

The scales are exceedingly thin, and, apparently in consequence of containing very little bony matter, they are apt to run into one another and lose their distinctness when fossilized. But so far as the best preserved specimens enable me to judge they were large and circular, and their outer surfaces were marked by very slight and delicate, granular, radiating striæ, which may, however, be indications of internal structure and not of ornamentation (Pl. III. fig. 7). These differences from the scales of *Holoptychius* become particularly obvious when, as in the slab in the British Museum above referred to, specimens of the two genera lie side by side in the same matrix, or when, as in fig. 3, Plate III. detached scales of *Holoptychius* have become imbedded in the midst of a specimen of *Phaneropleuron*.

The cranial bones are smooth, or, at most, present irregular and scattered grooves. The cranium seems to have been much more compressed from side to side than in most Devonian fishes, but I can say little else respecting its structure, as it is much injured in all the specimens I have seen. In no specimen are the boundaries of the cranial bones defined. The operculum, however, is large. The orbit seems to have been situated far forwards, and the gape is long. Both the upper and the lower jaw are beset with a single series of sharp short conical teeth. One specimen on the slab 21620 in the British Museum, exhibits the only view of the under surface of the head I have met with, and proves that the jugular region was protected by bony plates. Whether there were more than the two principal ones, or not, however, I cannot make out with certainty.

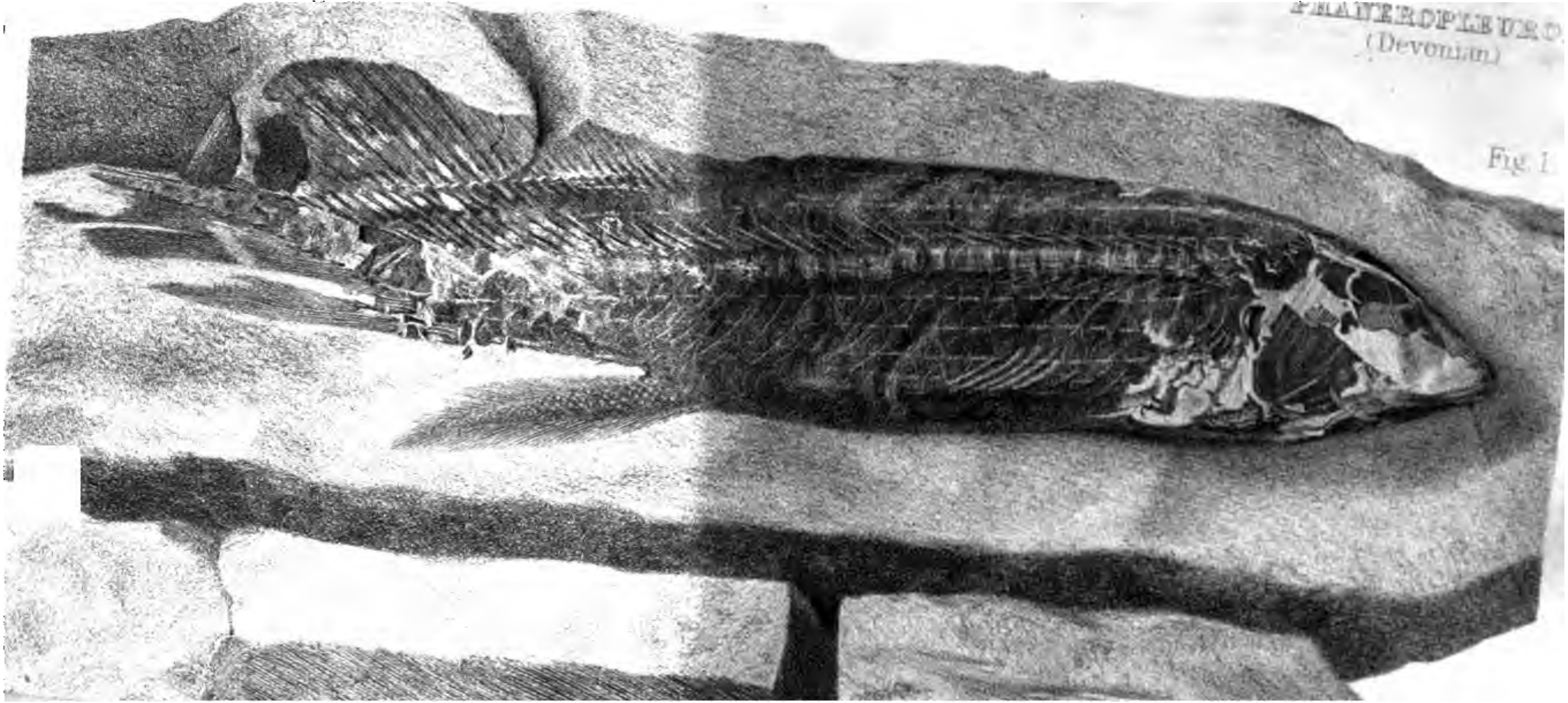
The pectoral arch is well developed, but I can say nothing as to its individual components, nor are the pectoral fins thoroughly well preserved in any specimen. Such parts of them as exist lead me to the belief that they were shorter than the ventrals, but like them acutely lobate.

No pelvic bones are discernible, but the ventral fins are beautifully displayed in two examples on the slab 26120 in the British Museum, and in another specimen marked 26117 in the same collection.

Their length exceeds the greatest vertical diameter of the body. A taper central lobe extends through the whole length of the fin, ending in a point at its fine end. It is covered throughout with cycloid scales, having the same characters as those of the body, and both edges are fringed with delicate fin-rays.

The notochord was persistent throughout the whole length of the vertebral column, while the superior and inferior arches were well developed and thoroughly ossified.

The neural spines are long, and are curved, so as to be somewhat concave forwards and upwards. In the posterior moiety of the body, elongated interspinous bones, narrow in the middle and



PHANEROPLEURO
(Devonian)

Fig. 1

expanded at the ends, are adapted to them. These interspinous bones increase in length from before backwards to beyond the middle of the dorsal fin, and support the fin-rays, whose bases are broad and solid, while they divide into a series of branchlets at their ends. There may be more than one fin-ray to each interspinous bone.

The dorsal fin, commencing with the posterior half of the body, gradually increases in height posteriorly, as its upper margin remains parallel with the axis of the body, while the dorsal line of the body converges towards that axis; the fin terminates posteriorly in an almost vertically truncated extremity.

The ribs attain a considerable length, even close to the head, and are continued through the whole length of the abdomen, passing gradually into the subcaudal bones. They are well ossified, and hence, in the fossil state, they stare through the thin integumentary scales of the fish so as to suggest its generic name.

The anal fin is somewhat lanceolate in shape, inclined downwards and backwards, and so long that its lower extremity is as distant from the axis of the body as the upper edge of the dorsal. It is supported by interspinous bones like those of the dorsal fin.

The inferior lobe of the caudal fin commences immediately behind the anal, and its rays appear to be supported by similar interspinous bones, at least anteriorly. It can be traced backwards to near the extreme end of the body. The superior lobe, on the other hand, seems to have been obsolete.

Explanation of Plate III.

Fig. 1. *Phaneropleuron Andersoni*, two-thirds of the natural size. From a specimen in the British Museum, No. 26120.

Fig. 2. Head of a specimen in the Museum of Practical Geology. The upper contour of the cranium seems to be slightly distorted. Natural size.

Fig. 3. Caudal extremity of a specimen in the British Museum, exhibiting the anal fin. A scale of *Holoptychius* lies above the end of the tail.

Fig. 4. Hinder part of the body, with ribs, neural arches, interspinous bones, and impression of the caudal part of the tapering notochord. In the Museum of Practical Geology.

Fig. 5. Head and body, with the opercular apparatus and impressions of the ribs and neural arches nearly undisturbed. In the Museum of Practical Geology.

Fig. 6. Teeth magnified.

Fig. 7. A scale magnified.

T. H. Huxley.

Jermyn Street, Nov. 1, 1861.

BRITISH FOSSILS.

DECADE X. PLATES IV. AND V.

TRISTICHOPTERUS ALATUS.

[Genus TRISTICHOPTERUS.* EGERTON. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Cœlacanthi.) Body fusiform. Cranial bones sculptured. Two dorsal fins; one anal fin; the rays of the second dorsal and the anal fin springing from three strong interspinous bones in each. Caudal fin springing from eight or nine similar bones. Vertebral centres ossified and prolonged through the upper lobe of the caudal fin.]

Tristichopterus alatus. SP. UNICA.

This is one of the many interesting additions made to the fossil Fauna of Scotland by the zeal and intelligence of Mr. Peach. Two specimens only have been obtained, one showing the general form of the fish, with the exception of the extremities of the head and tail, the other, with its counterpart, exhibiting in perfect preservation the structural and other characters of the fins and tail. The expanse of the latter and the opposition of the second dorsal to the anal fin are characters which might lead one to refer this form to the genera *Diplopterus* or *Gyroptychius*, but a rigid examination of the specimens convinces me that it formed a member of the Cœlacanthoid family, although presenting some important discrepancies from the other genera of that family. The points of resemblance are seen in the number and position of the fins, the curvilinear outline of the scales, and the prolongation of the central portion of the tail. The differences consist in the structural details of the fins and the ossification of the vertebral centres; but in these respects the deviation from the *Sauroidei-dipterini* is quite as great as from the *Cœlacanthi.*

Description.—The more perfect of the two specimens measures seven and a half inches in length; if to this we add two and a quarter inches, the dimensions of the tail supplied by the second specimen, and three-quarters of an inch for the absent portion of the head, the entire length of the fish will be ten and a half inches. The depth at the greatest diameter is two inches. The body is irregularly fusiform, the dorsal line being less curved than the ventral outline, and the anterior half of the body more obtuse than the caudal portion. The bones of the head (with the exception of a small fragment of the operculum) are wanting, but the impressions distinctly left upon the matrix show that they were sculptured in rather a bold pattern, not unlike the ornament on the cranial bones of some of the *Holoptychii*, and consequently differing in this respect from the corresponding parts in *Dipterus*. The pectoral fins are very indistinctly seen. They appear to have had a short obtuse lobe forming the base, and extending therefrom a set of numerous fin-rays more elongated than those forming the pectoral fin in *Dipterus*. The small anterior dorsal fin is situated at the commencement of the last third of the body, and is opposed to the ventral fins. The latter are broad and composed of numerous rays expanding from a short lobate base. Both these and the pectoral fins differ from the corresponding organs in *Dipterus* in having more numerous and longer rays.

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* From τρεῖς tres, στίχη series, πτερὸν ala.

The structure of the other fins is very singular and requires a more detailed description. The second dorsal fin is placed immediately opposite the anal fin, and resembles it so closely that one description will serve for both. In each of these fins the component rays spring from three interspinous bones, and these are attached to a single broad spinous apophysis. The latter bone is probably a composite one, formed by the union of three or more spines. The interspinous osselets have cylindrical shafts expanded at each extremity, the one for attachment to the vertebral spine, the other for affording a base for the insertion of the fin-rays. In the anal fin the anterior bone of the triplet is shorter than the others and than the corresponding bone in the dorsal fin. The fin-rays springing from the first bone are the strongest. The anterior ones are the shortest and they lengthen in succession until the maximum extent of the fin is attained. They are single at first, but bifurcate in the distal part of the fin. The transverse joints are numerous. The group abutting upon the first interspinous bone contains about six rays. The second bone carries about eight rays, more slender than the former and more frequently subdivided. The anterior ray of this group is the longest, the subsequent ones decreasing in length in succession. The third bone gives attachment to at least a dozen rays, finely fimbriated, and forming the posterior fan-like portion of the fin. The integuments extended over the interspinous bones as far as the commencement of the true fin-rays, thus forming the lobate base so characteristic of the fins in all the Cœlacanthoid fishes. The upper lobe of the tail contains numerous rays, the anterior ones being short and fulcral, forming a marginal fringe along the upper edge of the fin. A few of the upper fin-rays are given off from a set of short neurapophyses, but the terminal rays seem to abut upon the vertebral axis. This is prolonged through and beyond the caudal fin, and is furnished at its extremity with a few fine rays forming a kind of supplemental fin projecting beyond the terminal margin of the normal caudal fin. This peculiar form of tail is common to many of the Cælacanthoid genera, and is most fully developed in the genus *Cœlacanthus* from the Permian and Carboniferous beds. It differs from the "diphycercal tail" of Prof. M'Coy, in which the upper and lower rays of the true caudal fin form the terminal point. This form is characteristic of the genera *Diplopterus* and *Gyroptychius* belonging to the *Sauroidei-dipterini*. The lower lobe of the tail is constructed upon a plan similar to that above described as occurring in the second dorsal and anal fins, but the interapophyseal osselets are more numerous. They are eight or ten in number, and each carries four or five rays. These rays are stouter than those of the upper lobe and are more frequently jointed and subdivided; the rays, above the upper interapophysis, forming the central area of the tail, impinge upon the lower periphery of the vertebral column, and decrease successively in length so as to form a vertical termination to this lobe of the tail. The condition of the vertebral axis in this fish forms a remarkable exception to the general law hitherto applicable to the greater part (if not to all) the fishes of the Old Red Sandstone, and to all the *Cœlacanthi* hitherto described. If we except the genus *Dipterus* (some specimens of which show a tendency to ossification in the caudal region) all the Devonian genera have been considered *Notochordal* fishes, that is to say, the *chorda dorsalis* has persisted in its embryonic condition without any trace of segmentation. In the present subject, however, the whole of the vertebral axis has left its impression distinctly on the matrix in one specimen, and in the other the vertebræ of the caudal region are preserved entire. There can be no doubt entertained therefore that in this genus the ossification and segmentation of the column was complete, in which respects it stands alone among the contemporaneous fishes. The scales more nearly resemble those of *Dipterus* than any other, but the surface ornament is differently arranged. The enlarged representations of two scales, one from the flank, the other from the lateral line, most carefully drawn by the skilful pencil of Mr. Dinkel, show the characters more clearly than any description can do. The posterior margins of the scales are all curvilinear, differing in this respect from *Gyroptychius*.*

Affinities.—In assigning this new form to the Cœlacanthoid family, I have been mainly influenced by its resemblance in many respects to *Dipterus*. The latter genus was arranged by Professor Agassiz with the *Sauroidei-dipterini*, but I have long ago seen sufficient reasons for considering it a Cœlacanth, approximating more nearly to *Glyptolepis* and *Holoptychius* than to any other genera. Professor Pander, however, in his work on Fossil Ichthyology, a publication remarkable alike for the labour it evinces and the extraordinary beauty of the illustrations, has issued a monograph on the genus *Dipterus*, in which he disagrees with this arrangement (first published by Professor M'Coy), and seeks to establish a new family for its reception, which he designates "*Ctenodipterini*." Hugh Miller, so long ago as the year 1848,† made known the curious discovery that the fossil crania named by Professor Agassiz "*Polyphractus*," belonged to the genus *Dipterus*, and furthermore, that the palatal teeth called "*Ctenodus*" by the same author, constituted the dental apparatus of the same genus. Professor Pander seems to have arrived at the same conclusion in 1858, not being aware of the previous discoveries of Hugh Miller, whose claim to priority, however, he acknowledges in a postcript. At the same time, Hugh Miller exposed the fallacy of assigning two anal fins to *Dipterus*, proving the so-called anterior anal fin to be one of a pair of ventrals. Professor Pander entertains the same opinion, but does not allude to Hugh Miller's correction, nor does Professor M'Coy seem to have been aware of it, as he describes the genus as having two anals. The genera *Osteolepis*, *Diplopterus*, and *Glyptolepis* are also rightly deprived of the anterior anal fin in Professor Pander's publication. The term *Ctenodipterini* is intended to express the association of the dental apparatus called *Ctenodus* with the genus *Dipterus*, but it is an objectionable term, inasmuch as it

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* Professor M'Coy figures a scale (Plate 2 c. Fig. 2 a. British Palæozoic Fossils), which he describes as a scale from the back of *Gyroptychius angustus*. It very much resembles a scale of *Tristichopterus*.

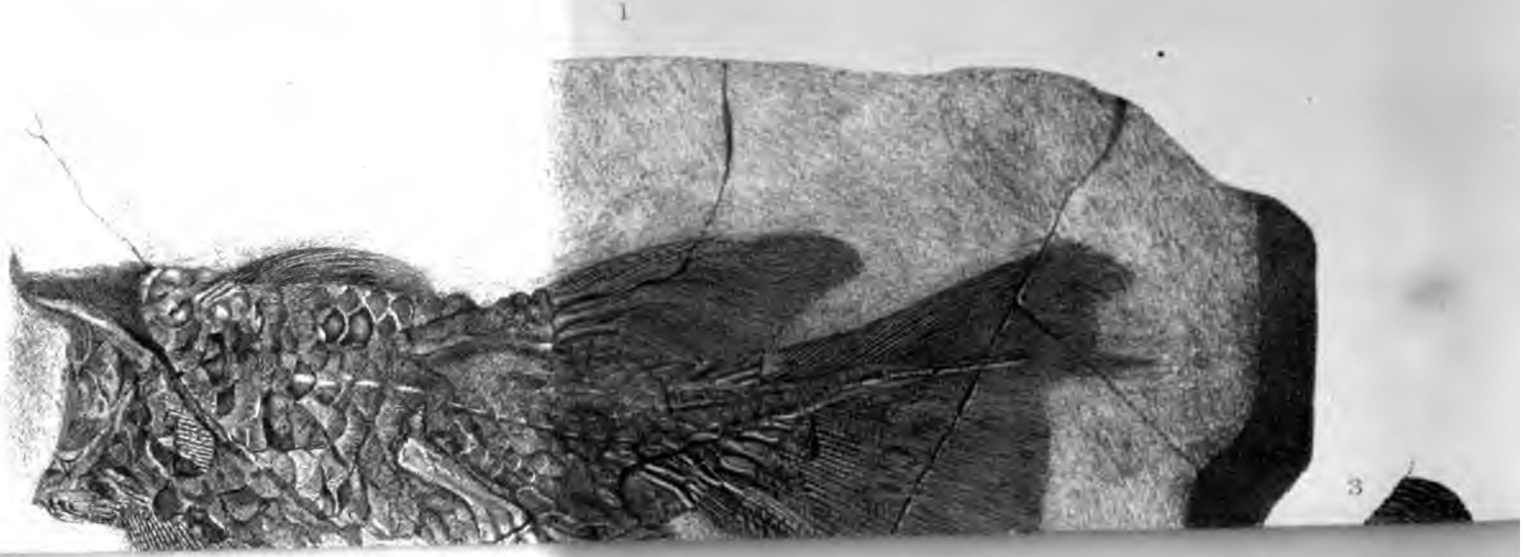
† *Witness* Newspaper, December 23, 1848.

Geological Survey of the United Kingdom.

DECADE X. PL. 5.

TRISTICHOPTERUS.

(Devonian.)



TRISTICHOPTERUS ALATUS.—*Egerton.*

[illegible]

Day & Son, Lith^rs to the Queen.

suggests the idea of a Dipterian fish with Ctenoid scales. If the family is proved to be well founded, the title *Ctenodo-dipterini* would be preferable. The genera *Ceratodus* of Agassiz, and *Conchodus* and *Chirodus* of M'Coy are referred by Pander to this family. The absence of all evidence as to the dental apparatus of *Tristichopterus* is much to be regretted. On other points the affinities between this genus and *Dipterus* are so striking that they cannot be classified in separate families.

Locality.—At the meeting of the British Association at Aberdeen in 1858, Mr. Peach read a short notice of several new forms of fossil fishes discovered by himself in the north of Scotland. The subject of the present Memoir is thus alluded to: "The great " interest attaching to the next arises from its having a short " vertebral column running from head to tail, and also strong in" ternal supports to the fin-rays. Whether these and the vertebral " column are of bone is still an open question. The scales are " large and coarse; it is about ten inches in length; and came from " the red and blistered sandstones near John o'Groat's House." The second specimen, contributing materially to the knowledge of the genus, is not mentioned by Mr. Peach. Both these specimens now form part of the collection in the Museum of Practical Geology.

EXPLANATION OF PLATES IV. AND V.

Plate IV.

Fig. 1. *Tristichopterus alatus*, size of nature.
Fig. 2. Structure of the tail, magnified.

Plate V.

Fig. 1. *Tristichopterus alatus*, size of nature.
Fig. 2. Scale of the flank, magnified.
Fig. 3. Scale from the lateral line, magnified.

P. DE M. GREY EGERTON.

Oulton Park, Nov. 15, 1860.

BRITISH FOSSILS.

DECADE X. PLATE VI. Figs. 1 and 2.

ACANTHODES PEACHI.

[Genus ACANTHODES. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Acanthodei.) Body fusiform. Mouth large, opening upwards. Orbits encircled by four bony plates. Branchiæ exposed. Fins membranous, supported by strong spines. One dorsal spine near the tail; one anal below and slightly in advance of the dorsal; pectoral spines strong; ventral spines small. Scales minute.]

The genus *Acanthodes* forms the subject of the first article in Professor Agassiz's volume on the Ganoid fishes. At that time only one species was known, *Acanthodes Bronni*, from the Coal-measures of Saarbrüch. Before the completion of the work, two others had been discovered, *Acanthodes sulcatus*, from the Coal-measures at Newhaven, and *Acanthodes pusillus* from the Old Red Sandstone near Gordon Castle. In the description of the latter species, in his later publication on the fishes of the Old Red Sandstone, Professor Agassiz supplements the characters of the genus given in the former work, with all the information derived from these subsequent discoveries. It was reserved, however, for Ferdinand von Römer, of Breslau, to complete the anatomical details of this singular fish, by the examination of hundreds of specimens (as he himself recounts) of a new species, *Acanthodes gracilis* (*Holacanthodes* of Beyrich), discovered in the Permian strata of Klein-Neundorf, near Löwenberg.* Since the publication of this memoir (to which I must refer the reader for the many curious structural details therein described), the Old Red Sandstone of Scotland has contributed three additional species to this genus. These will be considered in this and the following chapter. Two of these novelties were discovered by Mr. Peach, and in recognition of the great services he has rendered to Palæontology I propose to designate the subject of this article by his name.

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* Ueber Fisch-und Pflanzen-führende Mergelschiefer des Rothliegenden bei Klein-Neundorf unweit Löwenberg, und im Besonderen über *Acanthodes gracilis* den am häufigsten in denselben vorkommenden Fisch.—Von Herrn Ferd. Roemer in Breslau, 1857.

Description.—Although somewhat longer than the *Acanthodes pusillus* from Tynet Burn, this is, nevertheless, one of the smaller species of the genus. The length of the only specimen found in tolerable preservation is about $2\frac{1}{10}$ inches. The depth of the the body is four-tenths, and caudal pedicle two-tenths of an inch. It differs remarkably from *Acanthodes pusillus* in these relative dimensions, being a thicker fish and less elegant in its proportions. The latter species is usually found doubled up upon itself, as if it had died a violent death. The Caithness species is also recurved, as if it had met with a similar fate; but, owing to the greater rigidity of the body, the distortion has been less excessive. The head seems to be large in proportion to the body, but this appearance may be due to the mutilated condition of this portion of the specimen. Owing to a forcible disruption of the integuments at the junction of the head and thorax, the former has been thrown up and crushed vertically, in consequence of which its natural proportions are disfigured by the lateral projection of the component bones. The pectoral fins remain in their proper position. They are supported by two strong spines, slightly recurved. The portions of the thoracic arch, to which these spines are attached, are seen sloping upwards from the articulation. They probably represent the coracoid bones. They are of slighter proportions than the corresponding bones in the genera *Cheiracanthus* and *Diplacanthus*. The ventral fins are situated about midway between the pectoral and anal fins. They are furnished with two spines, more slender than the other fin spines, but longer in proportion than in any other species of this genus. The dorsal fin is placed in a more forward position than the corresponding organ in the allied species. Instead of being slightly more remote than the anal fin, it is immediately above it. The spine which carries the fin is the strongest of the set. It is more curved than the dorsal spine of the other species of contemporaneous origin. The anal spine is also strong and curved. All the fin spines are ornamented with three or four longitudinal grooves. The tail is very broad for the size of the fish. The upper lobe projects beyond the lower lobe to a considerable extent, but does not taper off so gradually as in other species. The appearance of a bifurcation at the extremity is due to a separation of the integuments, either from pressure or decomposition. The scales are very minute, at the same time they appear to have been coarser than the scales of *Acanthodes pusillus*.

Locality.—This specimen was discovered by Mr. Peach about four years ago in a quarry of the Old Red Schist belonging to the Earl of Caithness, near Barragill. It is now in the Museum of Practical Geology in Jermyn Street.

PLATE VI. Figs. 3, 4, 5.

ACANTHODES CORIACEUS.

This singular little fish is another of the novelties produced at the Aberdeen meeting by Mr. Peach. It is not without hesitation that I refer it to the genus *Acanthodes*, but as the only alternative would be to establish a new generic definition, the preferable course, it appears to me, is the one thus adopted, since it is better to defer the introduction of a new title until good and sufficient materials substantiate its necessity, than to enter a new generic name on the list, already overcrowded, which may hereafter be found to be unnecessary.

Description.—The unique specimen of this fish discovered by Mr. Peach scarcely exceeds 1 inch in length. It reposes on the left side, having the ventral surface slightly upturned so as to display all the fins. It will be seen on referring to the enlarged representation most accurately delineated by the practiced and skilful hand of Mr. Dinkel, that the arrangement of the several fins is in close correspondence with the fin formula of the genus to which I have referred it. There are two pectoral fins, two ventral fins, one dorsal, and one anal fin, all armed with spines. The pectoral spines are the longest, and the ventral spines the shortest of the series. The dorsal and anal spines are intermediate in size, and both of the same length. The body of the fish is more slender and the fins more distant from each other than the corresponding parts of *Acanthodes Peachi*. The dorsal fin is also more remotely placed than in that species. These discrepancies forbid the idea I once entertained that it might possibly be the fry of that species. The most striking feature of this fish is the integumental covering. It has all the appearance of a thick corrugated skin, with here and there a trace of very minute scales. These are most evident near the caudal extremity, and a group of them from this spot has been carefully delineated by Mr. Dinkel. If the surface here seen be the true exterior layer, and not the result of decomposition, it would appear to be more granular than the coating of other Acanthodean scales.

Locality.—Mr. Peach found this specimen near Thurso, and described it as a smaller species than the preceding one "with strong and long spines, and as if clothed with a thick skin." The specimens figured are in the collection of the Museum of Practical Geology.

EXPLANATION OF PLATE VI.

Fig. 1. *Acanthodes Peachi*, size of nature.
Fig. 2. " " enlarged once.
Fig. 3. *Acanthodes coriaceus*, size of nature.
Fig. 4. " " enlarged twice.
Fig. 5. Scales of ditto, greatly magnified.

P. DE M. GREY EGERTON.

Oulton Park, Nov. 27, 1860.

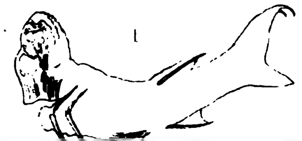
Geological Survey of the United Kingdom.

DECADE X PL. 6

ACANTHODES.

(Devonian)

1



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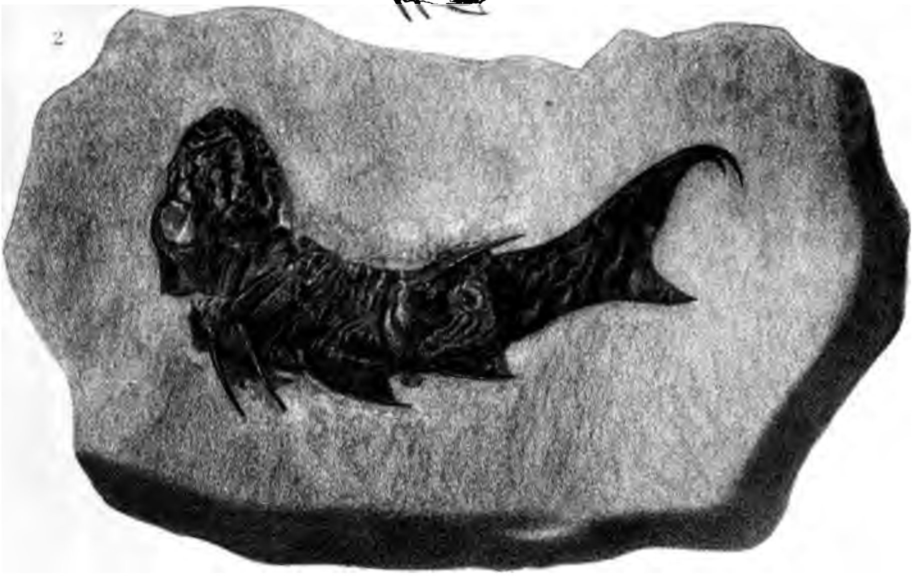

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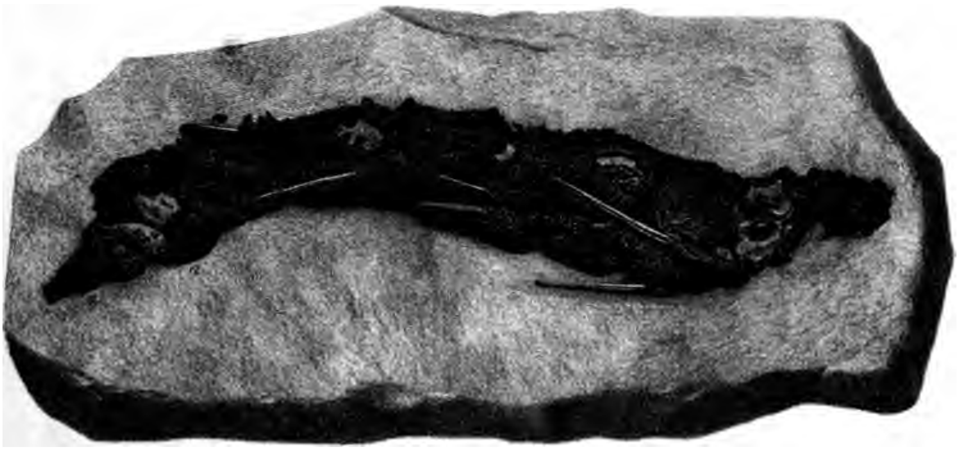

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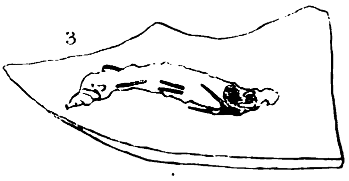

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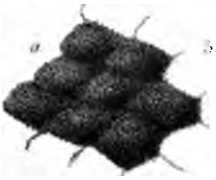


ACANTHODES PEACHI _ *Egerton*

ACANTHODES CORIACEUS _ _ *Egerton*

Dinkel lith.

BRITISH FOSSILS.

DECADE X. PLATE VII.

ACANTHODES MITCHELLI.

[Genus ACANTHODES. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Acanthodei.) Body fusiform. Mouth large, opening upwards. Orbits encircled by four bony plates. Branchiæ exposed. Fins membranous, supported by strong spines. One dorsal spine near the tail; one anal below and slightly in advance of the dorsal; pectoral spines strong; ventral spines small. Scales minute.]

SYNONYM. *Acanthodes antiquus*, EGERTON. Report of Brit. Assoc., 1859, p. 116.

At the meeting of the British Association for the Advancement of Science, held at Aberdeen in the month of September 1859, the Rev. Hugh Mitchell, of Craig near Montrose, communicated to the Geological Section a notice of the occurrence of fossil fishes in the Old Red Sandstone formation in Forfarshire. A cursory examination of the specimens exhibited in illustration of the memoir, satisfied me that the species discovered at Farnell were new to science, and I consequently named the subject of the present article *Acanthodes antiquus*. I subsequently saw two other new species of the same genus from the Old Red Sandstone of Scotland, and, therefore, cancelled the incorrect and objectionable specific affix, and substituted the name of the discoverer of this pretty and well characterized species.

Description.—The specimens I have examined of this pretty little fish vary from two inches to two and three-quarters of an inch in length. The one I have selected in illustration of this Memoir measures two inches and a half. The deepest part of the body (Pl. VII., fig. 2.) is at a point midway between the pectoral and the ventral fins. It here measures half an inch. The head measures about one-fifth of the entire length. The cranial bones are gracefully sculptured with deep sinuous lines. The orbit occupies an advanced position, and is embraced by a set of the singular orbital plates first noticed and described by Ferd. Römer as characteristic of the genus *Acanthodes.* The branchial apparatus also corresponds with that ot the other members of the genus. The outline of the body is remarkably graceful. It is fusiform anteriorly, and tapers gradually posteriorly to the base of the caudal fin. The latter organ is highly heterocercal, although the upper member is not so much extended as the corresponding part in the genus *Climatius.* All the other fins are supported by stiff spines. The pectoral spines are long and curved, the other fin spines are more slender and straight. The ventral fins are situated nearer to the anal than to the pectoral fins, and the dorsal spine is slightly nearer the tail than the anal fin. The species differs from its congeners in having the cranial bones more deeply sculptured, and in the form and position of the fin spines. It is most nearly allied to *Acanthodes Peachi*, but it differs from this species in the form of the body, in having the pectoral spines more curved, and the other spines straight, and in the more remote position of the dorsal fin.

Locality.—The deposit which has yielded this and the following interesting additions to the Fauna of the Old Red Sandstone of Scotland, is situated on the south-east bank of the Pow burn about half a mile south-west of the Farnell station on the Scottish North-Eastern Railway. It is described by Mr. Powrie as consisting mostly of fine grayish argillaceous shales, the lower beds splitting into fine laminæ nearly as thin as writing paper, and, when first opened, of a delicate cream colour. In a subsequent part of the paper the author says, "no painting could equal the beautiful appearance "some of the smaller fishes exhibit when the little slab in which "they have been entombed is first opened up, and still damp." The Rev. Henry Brewster of Farnell was the first to discover the fossiliferous character of these shales, but the Rev. Hugh Mitchell of Craig first ascertained the association of fishes with the organisms previously discovered, and called attention to the subject in a paper he communicated to the Geological Section of the British Association at the Aberdeen meeting in 1859. Through the liberality of Lord Southesk, to whom the quarry belongs, every facility has been afforded for exploring its contents, and the zealous labours of Mr. Powrie and the Rev. Henry Brewster have added considerably to the stock of materials collected by the Rev. Hugh Mitchell. I am

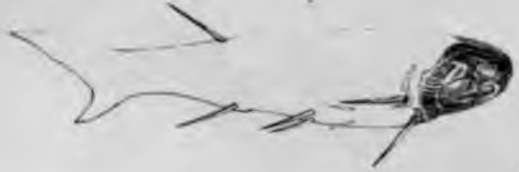
Geological Survey of the United Kingdom.

DECADE X. PL. 7

ACANTHODES.

(Devonian.)

1



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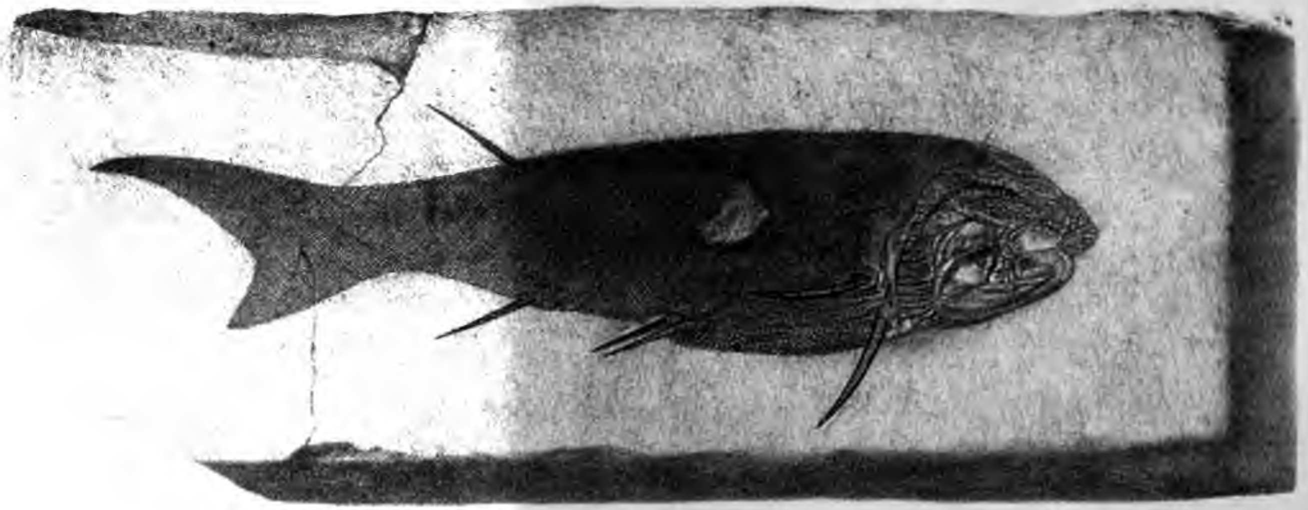


indebted to all these gentlemen for the generous confidence with which they have entrusted to me the fragile treasures of their several museums, although well aware of the risk of injury to which they must be submitted in travelling from one extremity of the kingdom to the other.

EXPLANATION OF PLATE VII.

Fig. 1. Outline of *Acanthodes Mitchelli*, size of nature.
Fig. 2. The same drawn in detail, twice the size of nature.
Fig. 3. Scales highly magnified.

P. DE M. GREY EGERTON.

Oulton Park, December 1860.

BRITISH FOSSILS.

DECADE X. PLATE VIII.

CLIMATIUS SCUTIGER.

[CLIMATIUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Acanthodei.) Body more or less fusiform. Tail heterocercal, attenuated. Fins membranous, supported by strong conical spines, striated longitudinally. Two dorsal spines; one anal spine; two pectoral spines; and two ventral spines. Three dermal spines on either side, between the pectoral and ventral fins. Dorsal ridge invested with large scutes.]

SYNONYMS.—*Brachyacanthus scutiger.* EGERTON, Report of Brit. Assoc. 1859, p. 116. *Ictinocephalus granulatus.* PAGE, Report of Brit. Assoc. 1858, p. 105.

The collection of specimens from the Farnell deposit, exhibited by the Rev. Hugh Mitchell at Aberdeen in 1859, contained, in addition to the *Acanthodes,* described in the preceding Memoir, several fragments of a small fish having considerable resemblance to the genus *Diplacanthus.* A closer examination of the best preserved specimen revealed, however, so many important points of difference that I was induced to assign to it a new generic title. The singularly short and massive character of the spines supporting the fins suggested the name *Brachyacanthus.* I have since found in Professor Agassiz's "Poissons Fossiles du Vieux Grès Rouge," the representation of a spine found at Balruddery, and described as a Placoid Ichthyodorulite, under the name of *Climatius reticulatus,* which I have no hesitation in identifying as belonging to a species of the Acanthodean genus under notice, although specifically distinct from the Farnell specimens. The name *Brachyacanthus* must consequently give way to the prior title *Climatius.*

Description.—The interest excited by the exhibition of these beautiful ichthyolites at the Aberdeen meeting gave such an impetus to the exertions of the explorers of the Farnell deposits that abundant materials shortly repaid their labours, not only for the full elucidation of the genus under notice, but for completing the knowledge of several other associated forms. Through the kindness of Mr. Powrie, the Rev. Hugh Mitchell, and the Rev. Henry Brewster, I have been enabled to examine the most perfect specimens hitherto discovered, and from these materials the following description of *Climatus scutiger* is derived. The specimens comprise two forms, the one of more slender proportions than the other. In the absence of more important differential features, it would be impolitic to attach specific value to a discrepancy of this kind; it may be due to casual or local influences, or be a sexual character. It suffices for the present to notice the fact, leaving the question of specific value to be settled by future investigation. The specimens range from one inch and a half to two inches in length, from the snout to the base of the tail. The latter organ is rarely preserved entire, in consequence of its extreme tenuity and delicate structure, and the fragile texture of the shale in which the specimens are imbedded; but I am informed by Mr. Powrie, who had the advantage of seeing the specimens when first uncovered, that the upper lobe of the tail measures about one-third of the total length of the fish. This measurement would give about three inches as the extreme length of a full grown individual. The form and proportions of the head closely resemble those of the head of *Acanthodes*. As in that genus, the surface of the cranial bones is richly chased, but the sculpturing, instead of being continuous in vermicular gyrations, is more isolated, so as to give the appearance of a repetition rather than a continuation of the pattern. The fins are all supported by strong conical spines, or rather spurs. They correspond in number with those of *Diplacanthus*, namely, two pectoral, two ventral, two dorsal, and one anal. They are all grooved longitudinally, the ridges between the grooves being slightly crenulated, as in *Ctenacanthus*. A few transverse lines (indicating, perhaps, periods of growth) occur near the base of the spines, crossing the longitudinal pattern, and causing the reticulate character which suggested the specific designation for the Balruddery spine described by Professor Agassiz. The pectoral spines are nearly as broad as long, short, and recurved. They are so firmly attached to strong coracoids that the latter appear to be integral portions of the base of the spines. The pectoral spines are easily distinguished from the other fin spines by the arrangement of the superficial pattern. In these the ridges run parallel with the posterior margin, whereas in the dorsal and anal fins they coincide with the anterior curve of the spine. The ventral spines are small; they are situated far back, in close proximity to the anal fin. The interspace between the pectoral and ventral fins is armed with three pairs of defensive spines, similar in character to, but somewhat smaller than, the ventral spines. Properly speaking, they are elongated scutes, forming part of the dermal envelope. They have a shallow cavity where attached to the integuments, and the cast of this depression when the spine is removed much resembles a broad scale. The great development of this cutaneous armature has suggested the specific affix I have given to this fish. Some other genera of Acanthodeans show a tendency to this character; for instance, Professor Agassiz describes the occurrence of two small ventral spines, situated between the pectoral and ventral fins, in *Diplacanthus crassispinus*, and some specimens of *Acanthodes Mitchelli* have faint traces of the same peculiarity. The anterior dorsal spine is inserted over the central pair of ventral scutes, or nearly midway between the pectoral and ventral fins. It is larger than the pectoral spine, and slopes backwards at a considerable angle. The spine figured by Professor Agassiz in the "Poissons Fossiles du Vieux Grès Rouge," plate 32, fig. 25, is probably the anterior dorsal spine of his species. The great inclination of the spine suggested the generic title *Climatius*. The second dorsal spine is longer, straighter, and more slender than its companions. The anterior margin is quite straight, but the hinder limb bulges out about midway between the apex and the base. The anal spine is situated slightly in advance of the base of the second dorsal spine. It is intermediate, both in size and character, between the two dorsal spines, being longer and straighter than the one, but shorter and more bent than the other. Some specimens retain faint traces of the organs attached to these spines. There is a doubt whether they were composed of true fin rays or not. My own opinion is that they were membranous, as in the other genera of Acanthodean fishes, and that the appearance of striæ is to be attributed to the impression of the longitudinal series of minute scales with which they were invested. I have already alluded to the extraordinary development of certain scales on the ventral surface of the body. A repetition of the same character, although not to the same extent, occurs on the dorsal ridge, the interval between the occiput and the first dorsal fin being roofed by a single row of umbonated scales, not unlike those occurring in the genera *Saurorhamphus*, *Eurypholis*, and *Dercetis*, although not so large in proportion to the dimensions of the fish. The scales on the other parts of the body are very minute, and resemble those of the other Acanthodean fishes in form and arrangement. The sculpturing of the surface is shown in the enlarged figure on the plate. The course of the lateral line is seen in some of the specimens. It runs along the flank about mid-distance between the dorsal and ventral margins.

I have recently received some spines from the Farnell beds, which correspond both in size and character with the specimens figured by Agassiz from Balruddery. They leave no doubt in my mind but that they are distinct from the species I have described; I therefore retain the specific name *C. scutiger* for the small species, leaving the Agassizian name for the larger species, but removing it from the Placoid order to the Acanthodean family of the Ganoids.

Locality.—All the best specimens I have examined of this fish are from the Farnell locality, where it appears to be one of the most abundant fossils. I am informed, however, by the Rev. Hugh Mitchell that it has also been found by him at Cauterland, in the parish of St. Cyrus; and at Tealing, five miles to the north of Dundee, by Mr. Walter McNicol.

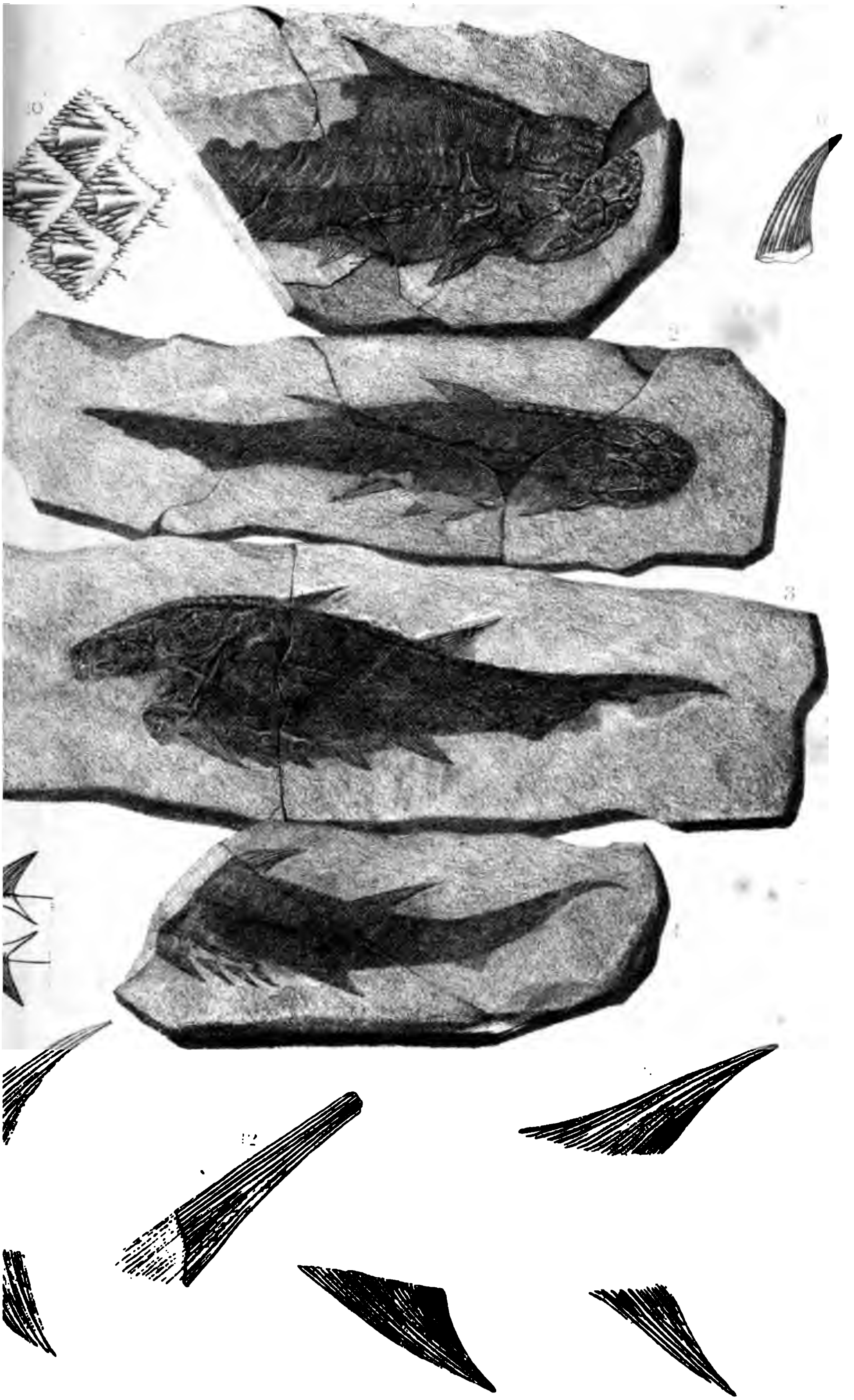
EXPLANATION OF PLATE VIII.

Fig. 1. *Climatius scutiger*, from Mr. Mitchell's original specimen.
Fig. 2. Ditto, belonging to Mr. Powrie.
Fig. 3. Ditto, ditto.
Fig. 4. Ditto, belonging to Mr. Brewster.
These four figures are twice the size of nature.
Fig. 5. *Climatius scutiger*. 1st dorsal spine.
Fig. 6. Ditto. Pectoral spine.
Fig. 7. Ditto. Anal spine.
Fig. 8. Ditto. 2nd dorsal spine.
Fig. 9. Ditto. Pectoral spines and attachment.
These five figures are four times the size of nature.
Fig. 10. *Climatius scutiger*. Scales highly magnified.
Fig. 11. *Climatius reticulatus*. 1st dorsal spine from Agassiz's "Poissons Fossiles du Vieux Grès Rouge," pl. 33, fig. 25.
Fig. 12. *Climatius reticulatus*. 2nd dorsal spine from Farnell.
Fig. 13. Ditto. Pectoral spine from Farnell.
The last three figures are the size of nature.

P. DE M. GREY EGERTON.

Oulton Park, December 1860.

Geological Survey of the United Kingdom.



BRITISH FOSSILS.

DECADE X. PLATE IX.

DIPLACANTHUS GRACILIS.

[Genus DIPLACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Acanthodei.) Body fusiform. Tail heterocercal. Fins membranous, each supported by a spine. Two dorsal fins, one anal fin, two pectoral fins, and two ventral fins. Mouth large. Teeth conical.]

The genus *Diplacanthus* comprises a greater number of species than any other Acanthodean genus, at the same time it does not appear to have been nearly so numerous in individuals as the allied genus *Cheiracanthus.* Professor Agassiz has described four species, viz., *Diplacanthus striatus* from Cromartie, *Diplacanthus striatulus* from Lethen, *Diplacanthus longispinus* from both the above-mentioned localities, and *Diplacanthus crassispinus* from Caithness and Orkney. To these Professor M'Coy has added two species from the latter locality, viz., *Diplacanthus gibbus* and *Diplacanthus perarmatus.* The newly-discovered ichthyolitic deposit of Farnell has supplied a seventh species, which I proceed to describe.

Description.—The only specimen I have yet seen of this species belongs to the Rev. Henry Brewster of Farnell, and was forwarded to me with many other interesting specimens by Mr. Powrie of Reswallie, Forfar. It is in excellent preservation with the exception of the extremity of the tail, which is wanting. It measures four inches in length by three-quarters of an inch in depth. Were the specimen entire, it would probably be half an inch longer. On comparing these dimensions with those of the other species, it appears that the proportion of the depth to the length is considerably less in the species under consideration. *Diplacanthus striatulus* is in this respect most like *Diplacanthus* *gracilis*, but the difference of the depth to the length in an individual of similar length, namely four inches, would be a quarter of an inch in excess. In consequence of this striking feature the Farnell *Diplacanthus* is at once recognized by its slender form and elegant proportions. The head is small, but remarkable for the large size of the oral aperture. The dentigerous bones, from the posterior angle of the mouth to the snout, measure three quarters of an inch. They seem to have been armed with a single row of conical teeth, the impressions of which are discernible, although rather indistinct. In this character the genus *Diplacanthus* resembles *Cheiracanthus* and *Cheirolepis*, and departs from *Acanthodes*. The orbit is placed well forward, and rather high in the skull. The arrangement of the opercular bones and branchiostegous rays corresponds with that of the homologous parts in the genus *Cheiracanthus*. The pectoral spine on either side is attached to a strong coracoid bone, having a straight styliform shaft, and an expanded base. The spines themselves are long, straight, and slender. The ventral spines are about half the length of the pectoral spines, and slender in proportion. They are situated nearer to the anal fin than to the thoracic arch. The position of the first dorsal spine is the most distinctive feature of the species. In all the other Diplacanths it is inserted immediately behind the supraoccipital process, nearly above the base of the pectoral fins, and is the strongest spine of the series, whereas in this species it is situated midway between the occiput and the second dorsal spine, over the interspace between the pectoral and ventral fins. It is also smaller than the second dorsal and anal spines. These characters may hereafter prove of generic value. The second dorsal spine occupies its normal place immediately opposite the anal spine. It is quite straight and much longer than the first dorsal spine. The anal spine resembles it in all respects except in size, in which it is rather inferior. All these spines are straighter and slighter than the fin defences of the allied species. The base of the caudal fin is large, the lower lobe rounded posteriorly, and the fin broad. The upper lobe is deficient; some traces remain of the endoskeleton in the preservation of the superior spinous processes of the anterior portion of the vertebral column, which seem to have been partially if not wholly ossified. The scales are minute, having a rhomboidal outline and a granular surface.

Locality.—The specimen figured was found in the Farnell beds, associated with *Acanthodes Mitchelli*, *Climatius reticulatus* and

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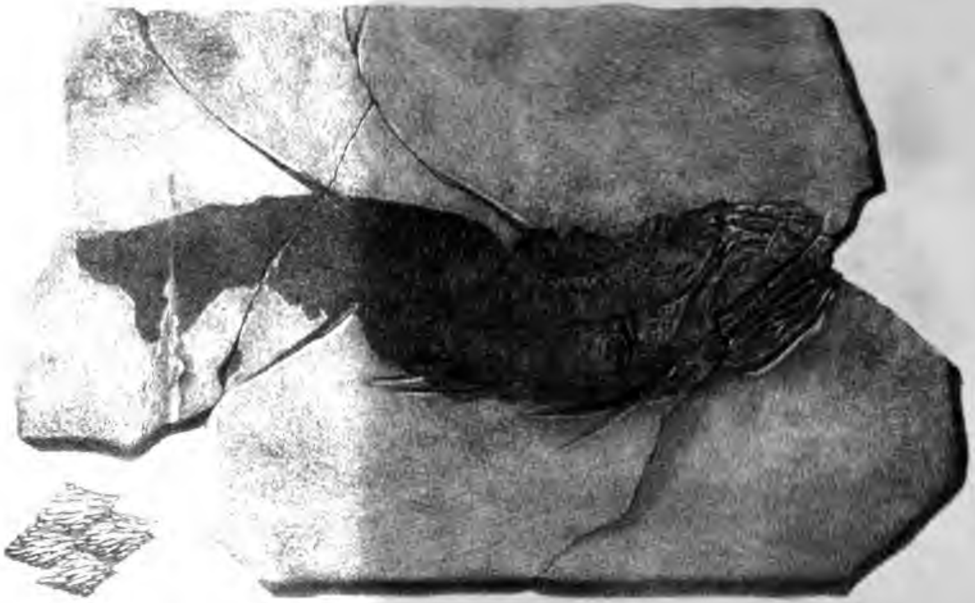
DIPLACANTHUS.
(Devonian)



US GRACILIS _ *Egerton.*

scutiger, *Parexus recurvus*, and other fossils characteristic of the Old Red Sandstone of that locality.

EXPLANATION OF PLATE IX.

Fig. 1. *Diplacanthus gracilis*, belonging to Mr. Brewster.
Fig. 2. Scales highly magnified.

P. DE M. GREY EGERTON.

Oulton Park, January 1861.

BRITISH FOSSILS.

DECADE X. PLATE X.

CHEIRACANTHUS LATUS.

[Genus CHEIRACANTHUS. AGASSIZ. (Sub-kingdom Vertebrata. Class Pisces. Order Goniolepidoti. Family Acanthodei.) Body fusiform. Tail heterocercal. Fins membranous, each supported by a strong spine. One dorsal fin, one anal fin, two pectoral fins, and two ventral fins. The dorsal spine situated above the interspace between the ventral and anal fins. Pectoral spines articulated to two strong coracoid bones. Scales minute. Teeth small, conical.]

The generic characters of *Cheiracanthus* are so clearly defined by Professor Agassiz in the "Poissons Fossiles du Vieux Grès Rouge," and the differences between this and the other Acanthodean genera so fully elucidated, that neither amendments nor additions are required notwithstanding the rapid progress of discovery since the publication of this standard work. Three species are therein described, *Cheiracanthus Murchisoni* from Gamrie, *Cheiracanthus microlepidotus* from Lethen and Cromartie, and *Cheiracanthus minor* from Orkney. Professor M'Coy has since described two species, *Cheiracanthus pulverulentus* and *Cheiracanthus grandispinus*, both from Orkney, the latter being the largest and most striking species of the genus. In consequence of the stimulus given to the exploration of the Old Red Sandstone deposits of Scotland by the meeting of the British Association at Aberdeen in September 1859, localities which had been previously but slightly examined were opened up, and yielded a rich harvest to the scientific labourers in Palæontology. Amongst others, the quarries at Tynet Burn were extensively explored through the liberality of the late Duke of Richmond, who employed a gang of workmen expressly for the purpose. Some of the best specimens discovered were forwarded to me by his Grace for examination, and amongst other novelties and many well-known species, I detected a new species of *Cheiracanthus*, which I have named *Cheiracanthus latus*.

Description.—On separating all the specimens of *Cheiracanthus* from the other genera with which they were associated it was evident that they indicated two distinct forms, one with a long tapering body and the fins rather distant from each other, the other short and thick, and having the fins closely approximated. The former is probably identical with *Cheiracanthus microlepidotus*, so common at Lethen; the latter I consider to be new. Both species appear to have been very abundant in the Tynet locality and to have been gregarious, but *Cheiracanthus latus* seems to have been most numerous. The collection forwarded to me contained above fifty examples, more or less perfect, of this fish. The length of an average-sized specimen is about six inches from the nose to the extremity of the tail, and the depth in front of the ventral fins one inch and a half, being an excess of one quarter of an inch as compared with a specimen of *Cheiracanthus microlepidotus* of similar length. The head is seen in profile, and measures an inch and a quarter in length from the point of the lower jaw to the posterior edge of the operculum. The mouth is large and horizontal; the teeth are not preserved in any of the specimens. Judging from the character of the dentigerous bones they were probably small and in single rows. The branchiostegous rays are very numerous, and extend high up in the opercular space. They are composed of a harder substance than the surrounding parts, being almost as dense as the fin spines, and are consequently preserved in most of the specimens. The pectoral fins are large and triangular. They are supported by a pair of strong spines, slightly curved and measuring one inch and a quarter in length. These are attached to a pair of coracoid bones, broad at the point of articulation and tapering upwards. A short process extends downwards from the same point on either side, meeting its fellow in the median line, and completing the thoracic arch. The large expanse of the pectoral fins required a powerful fulcrum such as this to enable them to fulfil their functions. The ventral fins are situated midway between the pectoral and anal fins. The spines supporting them are straight, and have their bases inserted in the integuments without any trace of pelvic bones. The dorsal fin occupies the middle of the back, the point of insertion of the dorsal spine being opposite the interspace between the ventral and anal fins. It is a large triangular fin attached to a long and straight spine deeply implanted in the muscular tissue. The anal fin spine occurs midway between the ventral spines and the base of the caudal fin, the membranous portion extending as far as the anterior margin of the latter organ.

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DECADE X.

CHEIRACA

(Devonia

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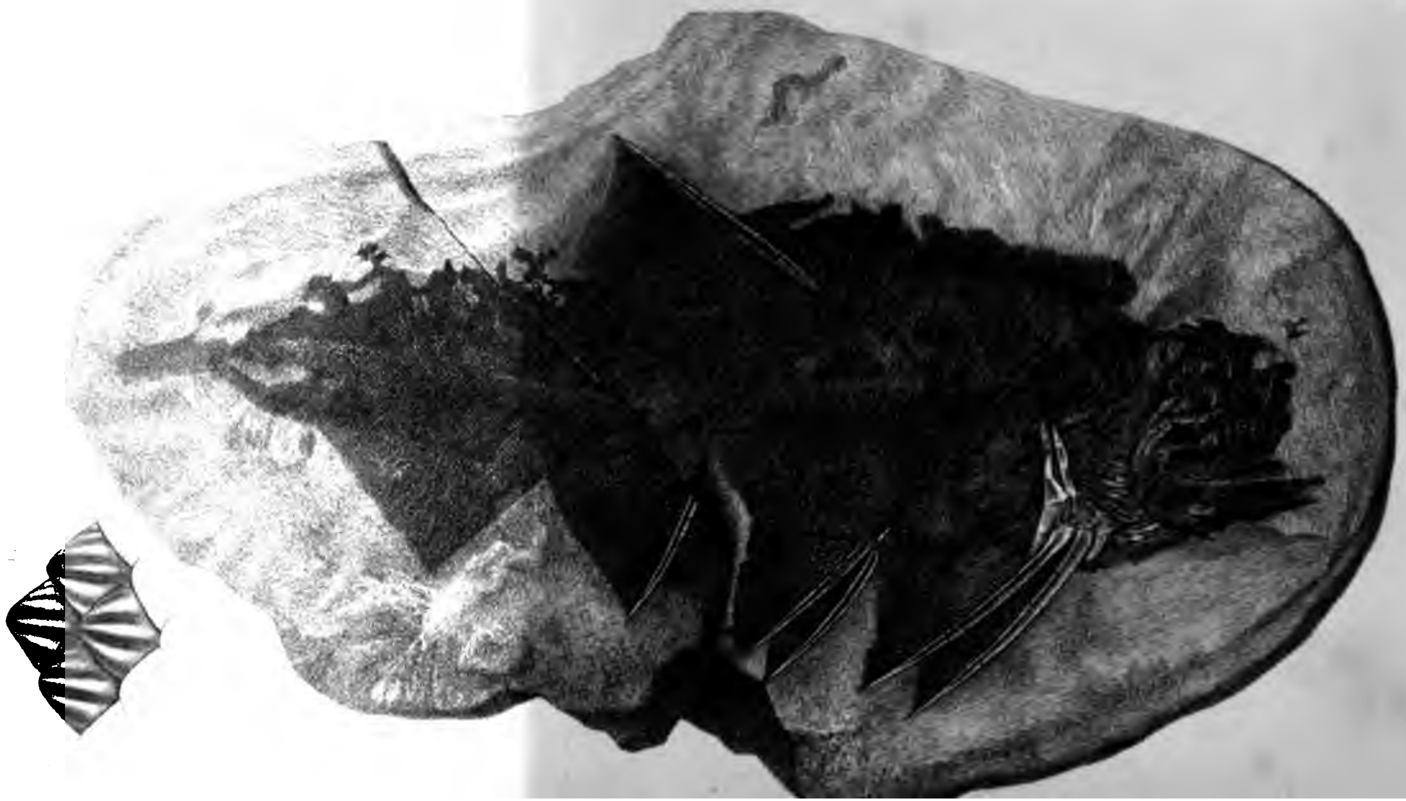

The pedicle of the tail is very deep, and terminates in a broad fin, of which the upper lobe greatly exceeds the lower lobe in extent. The scales are smooth, umbonated below, and neatly sculptured on the outer surface with four or five parallel grooves. They are of uniform size over the entire body. The broad tail, large fins, and close arrangement of these on the ventral surface distinguish this species from all those hitherto described.

Locality.—All the specimens I have seen of this species are from Tynet Burn, where they occur in nodules similar to those found in the contemporaneous deposit at Lethen Bar.

EXPLANATION OF PLATE X.

Fig. 1. *Cheiracanthus latus.* Size of nature.
Fig. 2. Scales magnified.

P. DE M. GREY EGERTON.

Oulton Park, November 1860.

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